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## ORIGINAL ARTICLES.

### I.—Note on some recent additions to the Vertebrate Fauna of the Norfolk "Pre-Glacial Forest-Bed."

By E. T. Newton, F.G.S., F.Z.S.

(PLATE IV.)

SINCE the publication of my last notes on the Vertebrata of the Norfolk "Forest-Bed" in this Magazine,[1] several new forms have been identified,[2] and we are now under obligation to Mr. W. Barker and Mr. A. Savin, whose diligent search in these beds has brought to light four species not hitherto recorded; three of them are bones of Birds, and therefore especially interesting, as so few remains of this class have been determined from British Pre-Glacial deposits. I have to thank Prof. Stewart and Dr. Garson for the facilities they have afforded me on this, as on other occasions, when comparing specimens in the Hunterian Museum of the Royal College of Surgeons; and for similar assistance at the British Museum I am indebted to Mr. R. Bowdler Sharpe and Mr. Oldfield Thomas.

Lutra vulgaris (Otter). (Pl. IV. Figs. 1, 2.)

A left ramus of a lower jaw has been found by Mr. A. Savin in the "Forest-Bed" exposed on the shore at East Runton, near Cromer, which enables us to add the above-named species to the Pre-Glacial fauna of the East of England. This specimen has the extreme front and hinder part broken away; but the alveolar margin is complete from the socket for the canine to that of the hindermost molar, leaving no doubt therefore as to the number of cheek-teeth, namely, five, three premolars and two molars. The large sectorial tooth (pm. 1) is well preserved, and agrees in all particulars with the same tooth in the common Otter. The two anterior outer cusps of this tooth are sharp and show slight facets due to contact with the upper sectorial tooth; while the inner cusp is not so high as the median outer cusp. The hinder part of the tooth is low with the upper surface concave; and a distinct cingulum extends along the lower part of the outer surface of the crown. The rest of the teeth are absent; but the number, position, and size of the alveoli agree exactly with

[1] Geol. Mag. Dec. II. Vol. X. p. 433.

[2] *Vide* Quart. Journ. Geol. Soc. vol. xxxix. p. 575; vol. xli. p. 243; and vol. xlii. p. 316.

those of the Otter; in fact, in every particular, the agreement is so close there can be no question as to their specific identity.

MEASUREMENTS.

| | | |
|---|---|---|
| Length of alveolar border for cheek-teeth ..... ..... | 34·5 | millimètres. |
| Depth of ramus under sectorial tooth ..... | 13·5 | ,, |
| Length of sectorial tooth ..... ..... | 12·0 | ,, |
| Width of sectorial tooth ..... | 6·5 | ,, |

BUBO MAXIMUS (Eagle Owl). (Pl. IV. Figs. 3–5.)

The second specimen, also found by Mr. A. Savin in the "Forest-Bed" at East Runton, is a right tarso-metatarsus of a large Owl. This bone is perfect from the lower extremity upwards to the ridge for the attachment of the anterior tibial muscles, but the parts above this are wanting. The most marked characters of this bone are the deeply grooved hinder surface bordered by sharp ridges, and the backward extension of the distal articular surfaces for the second and fourth digits. The last-named peculiarity is such that when the bone is viewed from its lower extremity as in Fig. 5, it is seen to form rather more than a semicircle. The front and sides of this bone are much flattened, giving a square appearance to the shaft. At the lower part, in front, between and a little above the articulations for the third and fourth digits, is the perforation for the tendon of the adductor muscle of the fourth digit; and immediately above this a second, smaller foramen. Towards the lower part of the hinder and inner surfaces, there is a flattened space for the attachment of the fourth metatarsal.

The only Birds, so far as I am aware, with a tarso-metatarsus of this form, are the Owls, and some of these agree very closely with this "Forest-Bed" specimen, the species which comes nearest to it being *Bubo maximus*.

There is a marked difference between the tarso-metatarsi of different examples of this species; thus in the *Bubo maximus* in the College of Surgeons (No. 1602) this bone is not quite so long as our fossil, but is more robust, the upper part being wider and the shaft thicker. The example figured by Milne Edwards,[1] is not quite so stout, and therefore comes nearer to our fossil. A third specimen, in the College of Surgeons (No. 1602 A), is much more slender than the other two; it is as nearly as possible the same length as the fossil, but is even more slender. Possibly these differences may be due to sex, for the male and female of this species differ in size; but, be that as it may, this "Forest-Bed" fossil bone is within the extremes of variation of the tarso-metatarsi of *Bubo maximus*. The front of the fossil is flatter than in either of the recent examples examined; but as this is due to the sharp muscular ridge on the outer edge, possibly age may have much to do with it. Length of bone from distal end to tibial crest, 55 mm. Greatest width of distal end, 22 mm. Width of shaft in middle, 7·5 mm.

SPATULA CLYPEATA (Shoveller Duck). (Pl. IV. Figs. 6, 7.)

A small but perfect left coracoid of a bird, found by Mr. W.

[1] Oiseaux fossiles, pl. 189, f. 1.

Barker in the Freshwater portion of the "Forest-Bed Series" at West Runton, is referred to the above species. A comparison of this specimen with the series of avian coracoids in the College of Surgeons leaves no doubt as to its nearest affinity being with the Anatidæ and especially with the Ducks; whilst its close agreement in size, form, structure, and muscular markings with the coracoid of the Shoveller Duck leaves one no option but to refer it to that species. The greatest length of the specimen is 44 mm., and the widest part, at the sternal articulation, is 17 mm.

PHALACROCORAX CARBO (Cormorant). (Pl. IV. Fig. 8.)

The last specimen which I have to notice was likewise found by Mr. W. Barker in the Freshwater-bed at West Runton. This is the upper part of a bird's coracoid with a markedly flattened inner surface, agreeing in this, as in other particulars, with the somewhat peculiar coracoid of the Cormorant. When comparing this specimen with recent forms, nothing could be found so nearly approaching it as the common Cormorant, and no doubt was felt as to its belonging to the same species. Some allied forms, such as the Shag and other Cormorants, were somewhat like, but *P. carbo* was certainly nearest and one might say identically the same. The Gannet, which is nearly related to the Cormorant, has a different form of coracoid.

Although other avian remains have been found in the "Forest-Bed," some evidently belonging to species differing from those which have been determined, it has not been possible to identify them. All the "Forest-Bed" birds at present known are *Bubo maximus*, *Phalacrocorax carbo*, *Anser* sp., *Anas* sp., and *Spatula clypeata*.

EXPLANATION OF PLATE IV.

FIG. 1. *Lutra vulgaris*, left ramus, outer surface. "Forest-Bed," East Runton.
" 2. Same specimen seen from above.
" 3. *Bubo maximus*, right tarso-metatarsus, front view. "Forest-Bed," East Runton.
" 4. Same specimen, back view.
" 5. Same specimen, end view of distal extremity.
" 6. *Spatula clypeata*, left coracoid, outer surface. "Forest-Bed," West Runton.
" 7. Same specimen, inner surface.
" 8. *Phalacrocorax carbo*, upper end of right coracoid, outer surface. "Forest-Bed," West Runton.

All the figures natural size.

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## II.—INTER-GLACIAL LAND-SURFACES IN ENGLAND AND WALES.

By A. J. JUKES-BROWNE, B.A., F.G.S.

THE exploration of the caves in the Vale of Clwyd, and the conclusions announced by Dr. Hicks at the last meeting of the British Association, have naturally aroused much interest; for if the facts are rightly interpreted by Dr. Hicks, and the deposits which are banked up against the north-western end of the cave are really of Glacial age, then it is clear that the contents of the cave date from a time anterior to the great submergence during which those deposits were formed. The occurrence of a worked flint-flake in the cave-earth makes this conclusion of the greatest importance, and

revives the question of Man's first arrival in Britain, carrying this back to Inter-Glacial, though not necessarily to Pre-Glacial times.

Dr. Hicks's inferences are, however, disputed by Prof. Hughes, whose objections may be summed up as consisting of two assertions —(1) that the deposits concealing the north-west mouth of the cave are not true Boulder-clays, but consist of rainwash and re-sorted Drift; (2) that if they did belong to what he calls the Clwydian Drift, they would still be Post-Glacial, and not Glacial.

Upon the first point it would appear that the majority of those who saw the excavation are against Prof. Hughes, and as fresh openings are to be made next June, we may hope that geologists who are acquainted with the Glacial beds of Cheshire and Lancashire will visit the place, and give us an authoritative opinion. In the mean time I may draw attention to the regularly stratified succession of sands and Boulder-clays in Dr. Hicks's section (see GEOLOGICAL MAGAZINE, December, 1886, p. 569); this is not the kind of structure which rainwash deposits usually exhibit.

Prof. Hughes's second objection is simply an unwarranted assumption; his only grounds for the statement that the so-called Clwydian Drift is Post-Glacial appear to be that it is of marine origin, and was formed during "the submergence which followed the extreme glaciation." Prof. Hughes may choose to assume that Post-Glacial time commenced with this submergence; but this is not the view which is usually held, and students of Pleistocene geology will naturally call upon him to define what he means by the terms Glacial and Post-Glacial. The latest authorities are agreed in correlating the Boulder-clays and gravels of the Vale of Clwyd with the similar deposits which spread over such large areas in Cheshire and Lancashire, and he must be a bold man who would exclude these from the category of Glacial deposits.

It is true that the late Mr. S. V. Wood, Jun., made a similar assumption with regard to the Drifts of Lincolnshire, speaking of a major and a minor glaciation, and referring the product of the latter (Hessle Beds) to the Post-Glacial era, because they contained *Cyrena fluminalis*, and were in his opinion contemporaneous with certain river-gravels which are usually called Post-Glacial. I have elsewhere shown, however, that the Hessle beds are so intimately associated with the underlying Purple clay that they cannot possibly be dissociated from it; and that as both were evidently formed under glacial conditions, it would be both confusing and illogical to call any part of the series *Post-Glacial*.

The fact is, as Prof. Boyd Dawkins has pointed out, the so-called Glacial period was only an episode in Pleistocene time; the length of this episode was necessarily different in different parallels of latitude, and consequently the term Post-Glacial can only have a local significance. Deposits which are evidently the products of ice-action must be called Glacial, and Post-Glacial deposits could not be formed at any given place until glacial conditions had ceased; hence it is probable that the Post-Glacial deposits of southern England are of earlier date than those of northern England, while in France the term Post-Glacial ceases to have any value at all.

In discussing questions of relative age, therefore, it would be much better to use the terms Older and Newer Pleistocene instead of Glacial and Post-Glacial, the true test of age being the constitution of the Mammalian fauna, and not the cessation of glacial conditions. I can see no reason why the newer Pleistocene fauna should not have occupied our southern and midland counties before the formation of the later glacial deposits of Cheshire and North Wales, provided only there was a time when a land-surface existed that was sufficiently free from snow and ice to permit of their immigration. If this were the case, Man was probably a contemporary immigrant; but this would not make him Pre-Glacial: consequently it is needless to compare the fauna of the Welsh caves with that of the Pre-Glacial Forest Bed.

The question then is, do the facts, so far as we know them, afford any evidence in favour of the supposition that there was a land-surface free of ice anterior to the submergence during which the later glacial deposits were formed? I think this question may certainly be answered in the affirmative; it is indeed a remarkable coincidence that three separate inquirers, each studying a separate district lying between the same parallels of latitude, should have independently arrived at conclusions which favour the above supposition. These three districts are (1) Lincolnshire, (2) South Derby and Nottingham, (3) North Wales.

One of the most striking points in the Pleistocene Geology of Lincolnshire is the contrast and distinction between the two great groups of glacial deposits; on this point I agree with the late Searles Wood, Jun., that the facts indicate the lapse of a very considerable interval between the formation of the older and newer deposits. Whether the older Boulder-clay was formed on land or beneath the sea is of course an open question, though I incline to the latter opinion; but it certainly seems to have been exposed to extensive erosion before the deposition of the newer red and brown clays. The facts favour the idea that a land-surface existed which was free of ice, but exposed to the action of rain and running streams, and that the district remained above water long enough for a distinct valley-system to be produced. Submergence then took place, the ice-laden waves of the North Sea attacked the coast-line and cut it back for many miles, forming a plane of erosion which terminated in a line of cliffs. More rapid submergence ensued, the cliffs and the wolds sank beneath the sea, and the valleys were filled up with gravels and Boulder-clays, which bear evidence of their marine origin in the shells which are found in them up to heights of 200 feet.[1] Here, therefore, we seem to have fairly good evidence of an inter-glacial land-surface.

Again, the Pleistocene deposits of South Nottingham and Derby have recently been described by Mr. R. M. Deeley, who divides the series into Older, Middle and Upper, assigning the East Anglian Chalky Boulder-clay to the Middle stage; from his description

[1] See Quart. Journ. Geol. Soc. vol. xli. p. 130, and "The Geology of East Lincolnshire," Mem. Geol. Survey, 1887, p. 91.

of the succeeding Newer Pleistocene epoch I quote the following:—"The evidence furnished by the deposits of the two previous epochs favours the assumption that, up to the close of Middle Pleistocene times, the area under consideration was uninterruptedly submerged to a greater or less extent . . . The deposits of the Newer Pleistocene epoch now to be considered indicate the first signs of subaerial erosion, and the consequent formation of river-gravel. . . . During this stage the rivers cut down their valleys through the older Boulder-clays and sands to within about twenty feet of their present depths, and left their gravels stranded as terraces at various heights above their present courses. Upon these *inter-glacial gravels*, or upon the older rocks, there frequently rests a Boulder-clay sometimes reaching a considerable thickness."[1] This later Boulder-clay would appear to be contemporaneous with the marine clays of Staffordshire and Cheshire on the one hand and of Lincolnshire on the other, though this point cannot be taken as proved.

Lastly, with regard to the Pleistocene succession in North Wales, we have the concurrent testimony of Mr. Mellard Reade, Mr. A. Strahan, and Dr. Hicks. Mr. Strahan sums up as follows:[2]—"While, however, there is a general agreement as to the marine origin of the sand, gravel and associated Boulder-Clays, there is an equally wide-spread opinion that the tough and very strong base-ment-clay seen at Colwyn Bay, Bryn Elwy, Llanefydd and other places in North Wales is the product of an ice-sheet." The distinction between the older and newer Boulder-clays seems therefore to be as marked in North Wales as it is in Lincolnshire; and if Dr. Hicks's views with regard to the relation of the caves to the newer glacial deposits are confirmed, the Pleistocene record in North Wales may be read thus:—

(1) Intense glacial conditions; Wales buried in ice, but the relative level of land and sea not yet known.
(2) Retreat of the ice, exposal of land-surface, and occupation of the district by Man and the newer Pleistocene Animals.
(3) Extensive submergence, during which the later (marine) Glacial beds were deposited.
(4) Elevation and re-occupation of the country by man and animals.

All recent observations tend to show the high probability of there having been a free land-surface over the greater part of England in the midst of what is usually called the Glacial period. During this Inter-Glacial period valleys were excavated, caves were formed, and a long process of subaerial detrition went on; the caves being occupied by Hyænas, while the plains were inhabited by an assemblage of animals very little different from that which again occupied the country after the second Glacial episode had passed away.

At present this is little more than a theory, but it will be interesting to see how far future investigations will confirm what I have suggested, and some geologists may perhaps be stimulated to search for further evidence bearing upon the question.

[1] Quart. Journ. Geol. Soc. vol. xlii. p. 466. [2] Q. J. G. S. vol. xlii. p. 386.

## III.—The Work of Ice-Sheets.

By J. E. Marr, M.A., F.G.S.,
Fellow of St. John's Coll. Camb., University Lecturer in Geology.

THE occupation of Britain by Ice-sheets in Pleistocene times has been established by the researches of Sir A. Ramsay, Dr. J. Geikie, Messrs. Peach and Horne, Tiddeman, Goodchild, and others. At the time that these inquirers made their observations, the very complex nature of the phenomena of the Greenland ice-sheet was hardly recognized, and many difficulties arose, upon which considerable light is thrown by a knowledge of the work of a modern ice-sheet. Under these circumstances it may be well to apply the information gained in recent years, and published by the Commission for Directing the Geological and Geographical Exploration of Greenland[1] to the clearing up of some of these difficulties.

A few remarks upon the nature of this continental ice, extracted from the "Meddelelser," may not be out of place.

The Greenland ice-sheet is stated to extend probably over an area about three hundred and fifty times that of all the glaciers of the Alps taken together, and it may be readily understood that the phenomena presented by such a mass are very different from those of the small glaciers so generally known. The difficulties of exploration of this great continental ice-sheet are very great, and the arduous undertakings of the Danish explorers must command universal admiration.

Owing to the cold polar current which bathes the eastern coast of Greenland, an almost impenetrable mass of ice blocks the shores between latitudes 60° and 69° N., and consequently our knowledge of that portion of the country is slight. On the western coast, however, a more favourable set of conditions exists, and the exploration of the ice-sheet has been undertaken from this side. The southern part of the country, around Cape Farewell, is occupied by gigantic glaciers, in the depressions between rugged mountains reaching a height of about 7000 feet, the summits of which, according to the observations of Herr Sylow, appear never to have been covered by moving ice; but north of the latitude of Julianehaab the ice-sheet is encountered, and the numerous fjords which indent the coast to the north of this are frequently barred at their inner terminations by great ice-cliffs which form the ends of huge glaciers projecting like tongues of ice from the ice-sheet of the interior into the valleys of the coast-region.

The confinement of the ice to the valleys in this region appears to be due to the elevation of the mountains surrounding the littoral. The country rises rapidly from the fringe of islets surrounding the coast, which have a maximum height of under one thousand feet, to heights of from 2000 to 4000 feet upon the peninsulas between the fjords. After this it falls towards the interior of the fjords, and again rises rapidly inland, so that one meets with summits of 3000 to 5000 feet and more, further inland; but as the ice itself rises in the interior, these heights become more and more buried in ice,

[1] "Meddelelser om Grönland," parts i.—vi. Copenhagen, 1879—1883.

their summits standing up from the surrounding ice as islets of rock known as "Nunatakker," until finally nothing is seen but a gently sloping plain of ice extending into the interior. The "Nunatakker" of Jensen, situated at a distance of over forty English miles from the edge of the ice-sheet, have a height of over 5000 feet above the sea. The ice to the east of them is elevated to a height of 5000 feet, whilst to the west it is considerably lower, as it becomes heaped up against the eastern side of the barrier like running water against a projecting rock. For a considerable distance to the west the ice is nearly horizontal, and afterwards it slopes downwards at a very small angle, having at first an average of 0° 49′ and afterwards at greater angles, which do not exceed 2° 14′.

The effects produced upon the movements of the ice by these partially buried barriers are most remarkable, and remind one strongly of the phenomena described by Messrs. Tiddeman and Goodchild in the area of and around the Pennine Chain.

If we examine the map of the directions of movement of the ice in Phillips's Geology of Yorkshire, third edition, part i. p. 9, and read it in the light of recent discovery, we are at once struck with the similarity of the conditions to those now presented by Jensen's and Dalager's "Nunatakker," as described in part i. of the "Meddelelser." This map may be taken to represent roughly the emergence of the Pennine "Nunatakker" above the ice about the period of maximum glaciation. The whole of the low tract to the west of the Pennines was occupied by the great masses of ice which, as shown by Messrs. Tiddeman and Goodchild,[1] came from the Lake District hills and from those of the south of Scotland. This ice passed over the Pennines at Stainmoor, and by the low watershed separating the valleys of the Ribble and Aire further to the south. The Scotch ice and apparently some of the Lake District ice passed over the low land between the northern extremity of the Pennine Chain and the Cheviot Hills, and it is generally recognized that this ice spread out far and wide over the Yorkshire plains.

This ice is considered by Mr. Goodchild not to have risen much above the 2400 feet contour-line in the Dale district examined by him, and judging from his map, the highest marks of glaciation occur here, where the ice would be heaped up against the Pennine Chain. In the district to the south described by Mr. Tiddeman, the marks of glaciation occur up to a height of 1400 feet on Bowland Knotts. The distance from Baugh Fell, where the highest marks are found in Mr. Goodchild's district, to Bowland Knotts, is over twenty miles, giving a fall of not more than 1 in 110 for the surface of the ice-sheet.

In the case of the Greenland "Nunatakker," we find that the greater part of the ice passes round the buried ridge of rock, describing a nearly complete circle, but that the upper portion flows over the depressions which separate the different "Nunatakker," and moves over the main mass of ice on the lee-side of the obstructing ridge, usually at right angles to the course of that ice, and that

[1] Q. J. G. S. vol. xxviii. p. 471, and vol. xxxi. p. 55.

the line of junction between the two is marked by a horse-shoe-shaped *moraine profonde*, which has been dragged up the more inland side of the rocky ridge over the passes, and becomes exposed as a terminal moraine at the extremity of the tongue of ice which has flowed over these passes. That this is true *moraine profonde* is indicated by the rounded and polished condition of all the stones composing it, showing that they have been brought from a distance, and not fallen from the Nunatakker to form superior moraines.[1]

The conflicting currents assumed by Sir A. Ramsay and others from an examination of the phenomena presented by the glaciation of Britain are here actually seen. Just as the great mass of ice presses against the "Nunatakker" of Jensen and Dalager, and is borne round it, whilst a thin superficial portion is carried over the passes between the "Nunatakker," bearing with it some of the *moraine profonde* of the ice-sheet, so the lower part of the Lake District ice appears according to Mr. Goodchild to have ridden northwards into the Eden Valley, as shown by the distribution of erratics along the western side of the Pennines to the north of Stainmoor, and the northerly pointing scratches near Crosby Ravensworth, whilst the upper portion flowed at right angles to this over Stainmoor, bearing with it part of the *moraine profonde* of the ice-sheet, including blocks of Shap granite.

Again, the "Nunatakker," by causing the deflection of the ice, allow of the formation of a hollow on the lee-side, whilst the main streams of ice which have been carried on either side of each "Nunatak" unite some way below the obstruction. This is shown in the case of "Nunatak" *i* of Jensen's group, where a lake occurs with ice-cliffs towering to a height of 600–800 feet above it, but especially by the small "Nunatak" *e* situated to the east of Dalager's "Nunatakker." In this case, the *moraine profonde* appears at the surface above the "Nunatak," and flows in a crescentic form around it, the horns of the crescent nearly uniting at the extremity of the hollow, which is filled with water forming a small lake on the lee-side of the "Nunatak."[2] The tendency of this must be to produce a "driftless" area on the lee-side of the obstruction, up to the point where the two streams of ice re-unite. Such a driftless area is described by Mr. Dakyns[3] as occurring on the east side of the Pennine chain, to the south of the Aire basin, except where the chain is broken by the Wye and Calder valleys.

Similar driftless areas[4] seem to be indicated by the lines on Prof. Phillips' map, as occurring on the east side of the Chain between its northern extremity and Stainmoor, and between the latter pass and the pass between the Ribble and Aire valleys. The curves of the distribution of drift in this map remind us strongly of the curves taken by the ice in rounding the Greenland "Nunatakker."

[1] *Cf.* Meddelelser, part i. plate v. figs. B′, B″, C′, C″, and C‴.
[2] Meddlelser, part i. plate v. figs. D′, D″.
[3] Q. J. G. S. vol xxviii. p. 383.
[4] *i.e.* not occupied by Scotch and Lake District drift.

To complete the parallel, the ice seems to have spread out at its extremity in a fan-like form on the low ground of East Yorkshire, just as does the Greenland ice to the S.W. of Dalager's "Nunatakker" on similar low ground, forming the great Frederikshaab glacier.

The moraine-like mound mentioned by Mr. Tiddeman as occurring on the east flank of Ingleborough, running parallel with the curving set of scratches, which according to him appear to have been caused by the ice rounding Simon's Fell, may be the relic of a crescentic moraine formed at the end of a small tongue of ice passing over the depression between Ingleborough and Simon's Fell, and sliding over the main mass of ice below in the same way as the tongues of ice slide over the main masses on the lee-side of the ridges which form Jensen's and Dalager's "Nunatakker." This mound, in any case, merits careful examination.

Another point illustrated by the Greenland ice-masses is the formation of contorted sands and clays associated with boulder-clay. Such deposits are usually referred to the action of the sea, or of running water, and it does not seem to be generally recognized that similar deposits are actually being formed in the ice itself.

In part iv. of the "Meddelelser," plate iii., bands of stratified sand and clay are seen interstratified with the ice at the extremity of a glacier which descends towards the fjord of Umanak, and these bands are not only overfolded, but also faulted along lines of crevasses in the ice. Similar bands are seen in plate iv. fig. 3, at the end of the glacier of Tuapagsuit, and above them, at one part, is a mass of moraine formed of gravel and large stones with their asperities worn off. If these masses of ice melted, they would leave contorted beds of sand and clay, with small faults, associated with morainic matter. May not some of the remarkable stratified deposits figured by Mr. Goodchild have been produced in a somewhat similar way?

The very conspicuous manner in which the Greenland valleys are stopped up by ice is also worthy of notice in connexion with the glacial theory of the origin of the Parallel Roads of Glenroy. The Jacobshavn glacier stops up both ends of a valley running parallel with its course, converting it into a lake which is separated from the glacier throughout the greater part of its length by a "Nunatak." The lower end of another valley considerably to the south of this is stopped by the ice-sheet, and the valley converted into a lake (Tasersiak), which is drained by a river running over the col at the head of the valley into the Strömfjord, just as in the case of the Märjelen See, only the Greenland lake is much larger than this. A similar lake drains into the N. Isortok fjord, and another into that of Alangordlia. Two similar lakes are formed to the east of Sermilik fjord, and several small ones to the east of Björnesund. North of the Frederikshaab glacier is a valley running north and south, the mouth of which is stopped by the Frederikshaab glacier, whilst a tongue of ice flows through a col situated half-way up the valley and bars the valley, one part of the tongue of ice flowing a small distance to the north, and another to the south, thus causing the conversion of

the valley into two lakes. On the east of the Frederikshaab glacier is the lake Tasersuak, bounded on the north by the "Nunatak" Kangarsuk, and stopped at its lower end by the Frederikshaab glacier, and having a tongue of the ice-sheet entering into it at the upper end.

The erosive power of an ice-sheet is well seen by a glance at the observations made upon the rivers which flow into the fjords of Nagsugtok and Isortok, and which have their origin at the ends of the tongues of ice which occupy the valleys continuous with these fjords.[1] The river from the first contained only 200—225 grammes of mud per cubic metre of water in the month of July, whilst the second in the month of June enclosed 9129 to 9744 grammes. This is compared with the amount carried by the Aar where it emerges from the glacier; it there contains only 142 grammes. The great difference presented by the rivers which fall into the two fjords is attributed to the fact that the ice moves with much greater speed towards the fjord of Isortok than towards that of Nagsugtok. It is calculated that the quantity of fine mud carried into the former of these fjords amounts to 4062 million kilogrammes per day. This mud is deposited in the interior of the fjord, which is filled up to such an extent in its upper portion that even flat boats cannot pass up it. What a powerful machine for the formation of the fine clay of "till" is here!

At the time when the Pennine Chain was nearly buried by the great ice-sheet from the west and north-west, the parts which stood out above the ice may still have possessed a meagre flora, for plants are found upon Jensen's Nunatakker which, as already stated, are situated about forty English miles from the edge of the ice, and have an elevation of over 5000 feet. Amongst these plants are *Draba alpina* and *Potentilla nivea*. Herr Kornerup has collected altogether 54 species of plants from various "Nunatakker."

Observations have been taken by members of the various expeditions as to the former extension of the ice, with the result that it is found to have stretched much further seaward in the period of great glaciation, but at the same time its height does not appear to have risen very much above the present level, for the summits of many mountains along the littoral show no traces of former glaciation. This seems to indicate that the thickness of the ice depends rather on the elevation of the country than on the intensity of the cold.

I have written the above slight sketch in hopes of calling attention to the importance of the results obtained by the Danish explorers in Greenland, to those who wish to elucidate fully the history of the ice-sheets of our own country.

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## IV.—The Cambrian Rocks of North America.

By Henry Hicks, M.D., F.R.S., F.G.S., etc.

CONSIDERABLE attention has been given of late years to the faunas of the rocks in North America considered to be the equivalents of the rocks usually classed as Cambrian in this country,

[1] Meddelelser, part ii.

and the facts which have been obtained are particularly interesting to British geologists. Two recent communications by Mr. C. D. Walcott, Palæontologist to the U. S. Geological Survey, are especially deserving of study in reference to the classification of these rocks,[1] and many facts of importance bearing on the same question are also given in papers by Mr. G. F. Matthew, of St. John's, N.B.[2]

That the classification found most suitable by the majority of those who have, during recent years, studied these rocks in Great Britain should now have been adopted by such experienced geologists in America, is very strong evidence of its wide applicability, and is a fact which should, I think, have influence on those who still hesitate in adopting it as the best means of bridging over the insuperable difficulties connected with the classifications of the rival schools of Sedgwick and Murchison.

In his introductory observations Mr. Walcott says,[3] "In using the name Cambrian in this paper for the series of strata characterized by the First or Primordial fauna of Barrande, I do not forget the claims of the name 'Upper Taconic,' which Dr. E. Emmons proposed for the strata now placed under the Middle Cambrian or Georgia Formation," and, "The term Cambrian is used from the belief that in so doing I approve of the view of those writers who hold that each of the distinguished authors, respectively, of the names Silurian and Cambrian will be fairly recognized, and geologic nomenclature advanced by the use of the names Cambrian and Silurian for the divisions of strata characterized by the first and third faunas as defined by Barrande. . . . . Of the presence of a well-defined geologic system beneath the strata characterized by the second fauna of Barrande or the Trenton fauna (including the Chazy and most of the Calciferous) of North America, on the North American continent, there is no question. The geologic sections given in this paper show it to have a total thickness of over 18,000 feet, and that its middle division has a known fauna of 43 genera, represented by 107 species. We also know that the Lower Cambrian or Paradoxides fauna has 32 genera and 76 species; that the Upper Cambrian or Potsdam fauna includes 52 genera and 212 species; that of the 393 species now known from Cambrian rocks but very few pass up into the Calciferous horizon of the Lower Silurian (Ordovician); and that the faunas of the two systems are so distinct in their general facies, and also in detail, that they are quite as readily separated as the Silurian and the Devonian or the Devonian and the Carboniferous. There is no doubt that in certain areas the faunas of the Cambrian and the Lower Silurian (Ordovician) systems are intermingled; but the same is more or less true of all the great divisions of the entire geologic series from above the great Archæan break to the Quaternary."

[1] "Classification of the Cambrian System of North America," Amer. Journal of Science, vol. xxxii. and "Bulletin of the United States Geolog. Survey, No. 30," 1886.

[2] "Illustrations of the Fauna of St. John's Group," Trans. Royal Soc. Canada, 1885, and "On the Cambrian Faunas of Cape Breton and Newfoundland," Canadian Record of Science, Oct. 1886. [3] Bulletin U.S. Geolog. Survey, No. 30, 1886.

Dr. Sterry Hunt has strongly advocated[1] the adoption of the term Ordovician (first proposed by Prof. Lapworth and now used by many authors in this country) for the American second division (Lower Silurian), and it is highly advisable that it should be adopted by American authors, as it would then be possible to know exactly to which portion of the Lower Palæozoic rocks the author referred. The tripartite division of the Lower Palæozoic rocks of Great Britain under the names Cambrian, Ordovician, and Silurian, seems at present the only means of avoiding confusion, and it is highly satisfactory, therefore, to find that some American authors are prepared to accept these terms to designate the primary divisions of the American Lower Palæozoic rocks.[2]

On the other hand, it is advisable that groups and series should still have local names, and the names should be those of places where the beds were first examined, or are well exposed. The following table expresses Mr. Walcott's views on the classification of the various groups that go to make up the Cambrian system of North America.

Classification of North American Cambrian Rocks.

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| UPPER CAMBRIAN. | Lower Calciferous. | Lower portion of the Calciferous Formation of New York and Canada.<br>Lower Magnesian of Wisconsin, Missouri, etc. |
| | Potsdam.<br>Knox.<br>Tonto. | Potsdam of New York, Canada, Wisconsin, Texas, Wyoming; Montana and Nevada; Tonto of Arizona; Knox Shales of Tennessee, Georgia, and Albama. The Alabama section may extend down into the Middle Cambrian. |
| MIDDLE CAMBRIAN. | Georgia.<br>L'anse au Loup.<br>Prospect. | Georgia Formation of Vermont, Canada, & New York.<br>Limestones of L'anse au Loup, Labrador.<br>Lower part of Cambrian section of Eureka and Highland Range, Nevada.<br>Upper portion of Wasatch Cambrian section, Utah. |
| LOWER CAMBRIAN. | St. John.<br>Braintree.<br>Newfoundland.<br>Wasatch.<br>Tennessee ? | Paradoxides beds of Braintree, Mass., St. John, New Brunswick.<br>St. John's area of Newfoundland. Lower portion of Wasatch section, Utah.<br>The Ocoee conglomerate and slates of East Tennessee are somewhat doubtfully included. |

[1] Trans. Roy. Soc. Canada, 1883, and "Mineral Physiology," etc. 1886, p. 528.

[2] In a former paper (Geol. Mag. Aug. 1885) I ventured to suggest that the term "Cambrian," instead of being confined to the lowest rocks, might fairly be extended as a main term to indicate the whole of the Lower Palæozoic rocks, and that the name "Georgian" (from St. George's Channel, on the borders of which the lower rocks are best exposed) would be a suitable term for the lowest rocks. I have since found that the Middle Cambrian rocks of Franklin County, Vermont, America, had previously been designated the "Georgia Group"; therefore it is evident that the adoption for a much larger division of the term "Georgian" would only lead to confusion. It is better, therefore, to confine the term "Cambrian" as in the present paper to the rocks underlying the "Ordovician."

In Bulletin No. 30, Mr. Walcott treats mainly of the fauna of the Middle Cambrian rocks and figures and descriptions of a large number of new genera and species are given. In Great Britain the fauna of these rocks is comparatively a poor one, and none of the typical American forms have as yet been discovered in them.

The American Middle Cambrian fauna is said to combine[1] "the characters of the Lower Cambrian and Upper Cambrian faunas and yet is distinct from each of them. . . . The conditions that developed the Middle Cambrian fauna appear to have been largely peculiar to the American continent. During the deposition of the St. John's series of the Lower Cambrian, or the Paradoxides strata, we learn from the European and eastern American sections, that the fauna was essentially of the same type over the entire basin (Atlantic), and, from evidence known to date, that the fauna did not extend west of a line passing north-east through Eastern Massachusetts to New Brunswick and Newfoundland. . . . From the data we now have, I think that during the existence of the greater portion of the Lower Cambrian (Paradoxides) fauna, a barrier existed that prevented its extension westward of the line mentioned; that towards the close of the time of the Paradoxides fauna that barrier was removed to the north-east, in the vicinity of Newfoundland, and the descendants from the Paradoxides fauna entered the westward seas and spread to the eastern and western basins and formed the Middle Cambrian fauna. What route was taken by the Middle Cambrian fauna after passing to the western side of the outer barrier is not yet traced, but I think from the indications we now have of a continental area, during Lower and Middle Cambrian time, in the central portion of the continent, that the fauna passed to the south around the southern end of the then existing land, and thence north along the west shore. In the Atlantic basin, the Paradoxides fauna persisted to a greater or less extent and mingled with the types of the Upper Cambrian fauna, as in the Upper Lingula Flags of Wales."

As Mr. Walcott is personally acquainted with the strata from which the fossils have been obtained, and has studied in the field most of the sections referred to, the conclusions at which he has arrived are important and highly deserving of very thoughtful consideration.

## V.—The Appearance and Development of Dicotyledons in Time.

By J. Starkie Gardner, F.G.S., F.L.S.

IT has been acknowledged by botanists that the methods generally pursued in determining fossil dicotyledonous plants have been scarcely such as were likely to lead to trustworthy results. Their study has, or should have, two practical aims. The one, that geologists may be able to determine the ages of strata, when they only contain fossil plants, with as much certainty as if they contained the remains of animals. The other, that botanists may be able to trace the evolution of the existing genera of plants from the palæontological record under conditions no less favourable than those at the disposal of the zoologist.

[1] American Journal of Science, vol. xxxii. p. 181.

Each new discovery should fall into a definite place, fill in some gap, and serve as a new point of departure.

That this is not the case when new fossil floras are described is but too apparent. When we sum up and examine the whole of the knowledge we possess of the ancestral forms of existing Dicotyledons, we find we are in a state of almost complete ignorance regarding them. We merely know that in certain formations, which we believe, from their included marine fauna, to be of Cretaceous age, perfectly developed leaves of Dicotyledons abound; but we do not know with any certainty how far we are justified in assigning them to existing genera, nor in what way they are linked to these. We know absolutely nothing of the successive steps by which even the leading existing families have been developed. We know nothing concerning the evolution of the Leguminosæ, the Proteaceæ, the Cupuliferæ. We see nothing beyond a more or less vague recognition of the fact that plants with simpler flowers should have preceded those with flowers of more compound character. We assume from the absence of Dicotyledons in older Cretaceous rocks that they must have been relatively somewhat rapidly developed; but the where, how, and whence, are still sealed books.

In the first place, we must inquire whether we can be absolutely certain that the ages of the Cretaceous beds which contain them are correctly known. Our first impression would be that the age of the Aix-la-Chapelle series is established on the most unequivocal evidence, for the beds with plants are intercalated between strata which belong lithologically and at first sight palæontologically to our Upper Greensand and Chalk, yet nevertheless the similarity may be completely misleading; and when we compare the faunas together critically, we shall realize that those of the Aachenian series are relatively considerably the younger. In an area of prolonged and gradual subsidence, as Europe undoubtedly was throughout the Upper Cretaceous period, the deep sea, or ancient gulf of the Atlantic, as represented by the Chalk, would gradually encroach further and further in every direction as the levels were lowered. At certain depths blue mud resembling that known as the Gault, and green mud and sands, similar to our Upper Greensand, would now be forming. These require a less depth and are more littoral than the deeper sea deposits corresponding with our Chalk, and in every area where chalk exists are seen to underlie it. During the Cretaceous subsidence, wherever oceanic waters penetrated, one or other or both of these qualities of mud must have preceded the deposition of true Chalk. Nothing could be more erroneous and more liable to beget confusion than to speak of all the blue mud as of one age, the green mud and green sand of another, the calcareous mud with chloritic grains as another, and the finer calcareous ooze as another. Their relative ages must be judged by the faunas they contain, and the greater or less resemblance of the organisms composing these to the existing types now found in the same qualities of sediment. There is no reason to suppose that the Cretaceous subsidence extended over Europe synchronously; it is at all events perfectly obvious that so long as Chalk

was being formed over any part of its area, the formation of those qualities of sea-bed called in their upheaved state Gault and Greensand must also have been forming synchronously over the lesser depths nearer land.

There is no physical reason whatever why the Aachenian, Danish, Irish, Scotch, or even Devonshire basins or gulfs, should not have begun to form contemporaneously with the deposition of the newest White Chalk in Kent and Sussex, or even with the much newer chalks that have since been denuded without leaving a trace. Stratigraphy, or rather petrology, is entirely at fault in this question, while palæontology tends to show that subsidence travelled outwards from the South-East of England and the North-East of France, and that the farther we recede from this centre, the younger will be the relative ages of the Cretaceous series, and the nearer the approach in them to what is recognized as a Tertiary fauna. Cretaceous forms would still be present in the newest of them, for it cannot be supposed that the extinction of these was sudden, or that they must necessarily be absent from a Cretaceous quality of sea-bed, even though its deposition was continued into Eocene times, for much of the life characteristic of the Cretaceous period is even now living in the deeper seas. It would on the other hand be very surprising to find Cretaceous forms in our Eocene muds, as these were formed under wholly different conditions which precluded the possibility of the existence of any faunas approaching in character those of the Chalk. The Aix-la-Chapelle flora, therefore, though overlaid by Greensand and Chalk with some Cretaceous types, is not necessarily as old as it appears to be stratigraphically. In countries so distant as America, we might have had Cretaceous formations in progress *pari passu* with the formation of our Eocene. The presence of some extinct or supposed extinct types is no certain proof of antiquity, for we only know them to be extinct now, but do not know when they became extinct, because we do not at present recognize the possibility of any deep-sea, or, in other words, deposits of Cretaceous aspect, being of Tertiary age. A great number of Cretaceous genera have been discovered to be not yet extinct; why then should we suppose that all those that are extinct disappeared simultaneously with the recession of a Cretaceous-depositing sea from our area, instead of the more rational hypothesis that they disappeared gradually, dropping out now one, now another, at any time between that period and the present day. If these considerations were not lost sight of, we should not find the presence of an Ammonite, Belemnite, or Inoceramus in a deep-sea deposit of America or New Zealand, held as proof conclusive that this is as old as our Cretaceous series, for they may merely be survivals of archaic types, which once swarmed in every condition of sediment, but which gradually took refuge in deeper water, to become extinct, no one can know when until our record of deep-sea deposits be more complete or better understood.

It is thus obvious that the supposed sudden appearance of a number of highly developed and almost perfectly distinct dicotyledonous floras during the Cretaceous period, at so many distinct parts of the

world, may be illusory. The first appearance of Dicotyledons remains, however, in any case remarkably sudden, and we are still left with very little clue as to how and by what progressive steps they originated.

The flora of Aachen is, I believe, the most extensive European Cretaceous flora known. Very little concerning it has been published, and neither it nor any other Cretaceous flora with Dicotyledons is adequately represented in any Museum in Great Britain. I had fortunately, however, an opportunity of going carefully through Dr. Debey's collection, and of visiting the quarries whence it had been obtained and even finding a few specimens. Its great antiquity is obvious, despite the presence of dicotyledonous leaves, for the Coniferæ depart very widely from existing species, or even from those of the Eocene, and among the Ferns there seem to be representatives of two singularly archaic genera, *Matonia* and *Thyrsopteris*, which do not occur in any Tertiary formation in Europe. I did not see, and am not aware of any good grounds for the supposed identifications of the Dicotyledons with living genera, such as Oak, Beech, Fig, Willow, Poplar, Bog-myrtle, nor with any genera of the Proteaceæ and Myrtaceæ. The leaves are of considerable variety of form and size, lobed, serrate and simple. There are many other localities in Europe from which similar Cretaceous floras have been obtained, but I am not so well acquainted with them.

A more ancient flora is that of Kome in Greenland, from which a single though apparently perfectly developed dicotyledonous leaf has been obtained, and referred, upon no ground whatever, except a fancied resemblance in the form of the leaf, to *Populus*.

The newer Cretaceous rocks of Greenland are said to contain species of a large number of existing genera; but these appear, with trifling exceptions, to be all determined upon the greater or less resemblance of the fossil leaves to some of the forms of leaf met with in such genera. The ages of the deposits are apparently very uncertain, and no specimens have yet found their way to our museums.

Another extensive and supposed Cretaceous flora from Vancouver's Island has frequently been referred to; but no specimens, so far as I know, exist in England.

A yet more extensive flora is that from the Dakota group at the base of the American Cretaceous series. The leaves are mostly lobed, resembling those of *Platanus*, *Sassafras*, and *Liquidambar*, but seemingly no fruits have yet been identified. A remarkable fact about this flora is, that while utterly disconnected from any other supposed Cretaceous flora in Europe, it bears a resemblance to the English Lower Eocene flora.

Cretaceous rocks containing Dicotyledons are also met with in New Zealand, but as yet little appears known about their floras.

It is quite apparent that the whole subject is still involved in the utmost obscurity, and that our actual definite knowledge of Cretaceous Dicotyledons practically amounts to very little. A man would indeed be bold who ventured to pronounce upon the precise age of any Cretaceous rock only from the character of the dicotyledonous

plants found in it. They require, before this can be done, and deserve, the most profound study.

We have next the supposed Pre-Eocene or Pal-Eocene floras, the chief of which are from the calcareous tuffs of Sézanne and the limestone of Gelinden. Large collections from both these localities have been in my possession, and are now in the British Museum. The stratigraphical evidence as to the age of the former is inconclusive, and the flora, rich in flowers as well as leaves, is unlike any other. The Gelinden flora is mainly composed of small and simple leaves, and is equally unlike any other, though its age seems to rest on a surer basis. It does not appear so far that the age of any Pre-Eocene or very old Eocene deposit could yet be recognized with certainty through its Dicotyledons.

We next come to the true Eocene deposits, and in the first place I am able to correct the erroneous assumption that no flora in our latitude comprising such modern and temperate-looking genera as *Platanus*, *Salix* and *Alnus* can be Eocene. At Reading, underneath the true London Clay with its typical marine fauna and the Reading series, leaves and fruits abound of *Platanus* as completely differentiated as existing species. With these are leaves and fruits of at least two leguminous trees, a large-leaved tree with melon-shaped fruits of the size of a walnut, and others forming a completely distinct and homogeneous flora, easily identifiable, and of perfectly defined age. It strongly resembles the Dakota flora of America, but does not seem known elsewhere in Europe. At Newhaven and at Coldam Common near Winchester, we have some Reading plants mixed with others belonging to the somewhat higher and also perfectly characterized horizon of Bromley, Lewisham, Croydon and Dulwich. *Platanus* here mingles with many new forms of leaf, for the most part strongly serrate, forming another group of plants quite unknown out of England. We now reach the well-known flora of Sheppey, led up to by the Herne Bay flora with *Alnus Richardsoni*. The Sheppey flora is extremely instructive, although it is so utterly distinct from any other that it is of little value for purposes of comparison. Such vast numbers of fruits have been collected from it that we may safely consider ourselves in possession of all the chief types, yet, singular to say, though the presence of trees with such easily recognizable fruits as Quercus, Fagus, Corylus, Castanea, Juglans, and some Proteaceous genera has been insisted upon in all the preceding dicotyledonous floras, not a single fruit even remotely resembling those of any one of these genera has been found among them. I do not yet realize the full significance of the fact, but so far most of the early dicotyledonous seeds seem to be clustered in fruit spikes as in *Alnus* and *Platanus* and the *Urticeæ*, and few seem of the nature of single-seeded nuts; nor up to this horizon is there any indication of winged-seeds such as the Maple, Ash and Elm. The oldest leguminous pods seem those from Reading. Next in age, and possibly even to some extent contemporaneous with the London Clay, is the flora of Alum Bay, also met with in France in the Grès du Soissonais. It is specially characterized by leaves of

*Myrica*, large-lobed leaves referred to *Acer*, and large simple leaves referred to *Ficus* and others, together with leaves of an immense Fan Palm. None of the determinations seem well grounded except *Myrica*, but there are several leguminous fruits, and the flora, as a whole, is easily and immediately recognizable, and would suffice to define the age of any beds in which it occurred.

Following in order is the Bournemouth flora, of great variety and extensively collected. It is very unlike any of the preceding, and were its age not absolutely known beyond the faintest possibility of doubt, it would have been referred to the Miocene, though actually older than the Bracklesham beds. It greatly resembles the Eocene floras from the South of France and of the Lignitic Series of America. Its affinity to the Oligocene floras of the rest of Europe appears so great that it is doubtful whether any distinct line can be drawn between them, but a little higher at Hordle, some of the Older Eocene Reading types seem to mingle with it.

All these Eocene floras are in beautiful preservation, and their stratigraphical position is definitely ascertained. A careful study of them will be repaid by much valuable information regarding the order of appearance of the genera of Dicotyledons, and would enable us to at once recognize the ages of any Eocene floras of adjoining countries. We should be able to argue from the known to the unknown, instead of the reverse as heretofore practised, and to construct for the first time a definite chronological sequence with which other floras might be contrasted and compared. The series can only be paralleled by the fossil floras of South-Eastern France, so beautifully described by Saporta.

In utilizing them for comparison with the fossil floras of other countries, the differences of latitude and longitude must be taken into account. Nor have we any right to suppose that all the plants preserved from an immense number of localities grew at the same elevation above the sea, while they may also have lived on very different stations, and under relatively dry or moist climates. Any of these influences, singly or combined, might profoundly modify floras, which, though perfectly contemporaneous, would then present very different compositions and aspects. Such considerations are so very obvious, that it would seem almost unnecessary to insist on them, yet we find in examining works on the Miocene floras that they have not been regarded. Floras from Spitzbergen in the North to Australia in the South have been classed as Miocene from a very slender fancied resemblance to those of Switzerland, and great series of strata have been assigned without sufficient reason to that age, not only in Central Europe, but in such distant lands as Greece, Madeira, Borneo and Sumatra, Sachalin and Alaska, and in fact wherever other evidence of age was absent. The resemblance of some of these floras to those of Switzerland is in many cases very shadowy and quite insufficient to justify any conclusion as to their age; but it is more than doubtful whether many of the supposed Lower Miocene Floras of Switzerland classed as Aquitanian are not themselves as old as the Eocene, and others, as the Mayencian, Oligo-

cene. Enough has, however, been said to show that no scientific value can attach in a general way to these determinations, and it will suffice to select the Greenland floras as an example, and to investigate the evidence upon which their supposed Miocene age was originally established. This was stated in 1868 to rest on an assured basis, when of 70 described species, 20 were alleged to occur in Miocene beds of Central Europe.

Of these two are Ferns, and appear respectively allied to *Osmunda regalis* and *Pteris aquilina*. They are ancient and northern forms which do not appear in any profusion to the south until Miocene times, though the *Osmunda* occurs in the old Eocene of Gelinden. Of Coniferæ two are referred to *Sequoia*; the first is erroneously united to *S. Couttsiæ* of Bovey, and the second, *S. Langsdorfii*, is a form known in the Cretaceous, and to which every fragment of distichous Coniferous foliage from the Tertiaries, that could not be placed in the third form, *Taxodium dubium*, has been at one time or another referred. The latter genus is found in the Middle Eocene of England. The sixth plant is merely a rush-like fragment referred to *Phragmites*. Of the thirteen Dicotyledons, ten are the most ordinary and widespread forms of leaf, such as occur in every flora, and of the three that are at all distinctive forms, two, the *Platanus* and *Populus Zaddachi*, are characteristic of the Lower Eocene of Reading, and the third has only been found elsewhere in the Oligocene of Armissan. The age of the Greenland formations can hardly be considered settled on such evidence as this, even were the determinations trustworthy, which is far from the case. Of course enormous quantities of plant remains have been described from Arctic formations since then, but they do not help to justify their reference to the Miocene, and the significant fact remains, that the most distinctive species belong to the Eocene floras of Reading and of Gelinden.

But supposing the identity of the floras were satisfactorily established, should this suffice to establish contemporaneous growth? Could floras of forest trees so closely related to existing species have grown at so recent a geological period synchronously with 24° of latitude intervening? This, it must be remembered, is the distance between Lombardy and Iceland, or Florida and Newfoundland. There is no reason why Eocene floras should be unrepresented round the Pole, and all the Eocene formations existing there be unfossiliferous. A series of sedimentary rocks destitute of fossils, and sometimes a thousand feet thick, is said to occur between the uppermost Cretaceous and lowest supposed Miocene, representing probably the temperate Lower Eocene period, when forests of leafy trees could no more have grown within the Arctic Circle than they would at the present day. As the temperature increased towards the Middle Eocene period, the temperate floras of the Lower Eocene would have migrated north, and we accordingly find, not fancied resemblances, but identity established by the presence of such peculiar and typical species as the Reading *Populus Zaddachi*, *P. Richardsoni*, *Platanus*, and the Gelinden *McClintockia* and *Cocculus Kanii*.

The Middle Eocene temperature was moreover exactly that re-

quired, according to Heer, to admit of the growth of the Greenland floras, for it was above 70° Fahr. in the South of England, lat. 50°, and 50° Fahr. in Greenland, lat. 70°, the distance, difference in temperature, and difference between the floras being as nearly as possible equivalent to that existing between Madeira and England at the present day.

When we reflect that the first dicotyledonous floras of any extent to be described were from the Miocenes of Italy and of Germany, we are no longer surprised at the immense relative importance that that formation assumed in the eyes of subsequent workers. It is small wonder that Heer was led by comparisons with these and with the well-known Miocene formation of Oeningen, to class all the dicotyledonous floras of Switzerland as Miocene. As each is in turn farther and farther removed in age from the horizon of Oeningen, it is seen to contain a decreasing proportion of true Miocene types. Thus, of the floras belonging to the Aquitanian stage, only six out of 34 species at Ralligen, 27 out of 193 species at Monod, and seven out of 47 at Paudèze, are common to Oeningen. Yet each in turn, as it came to be incorporated in the Miocene, has furnished fresh standards for comparison, each addition approaching more nearly to Eocene types, and departing more widely from those of the Miocene. By including the Swiss Aquitanian and Mayencian in the Miocene, and then in comparing Eocene and Oligocene floras of other countries with them, the latter would be shown to possess Miocene characters, for there can be little doubt that the Aquitanian floras are really Eocene, and the Mayencian are truly Oligocene. We thus get at the root of the matter, and though I could not induce the lamented Prof. Heer to understand the grounds of my contention, I have no doubt that had he lived to investigate our magnificent and typical series of English floras, he must have modified his views. The process of assimilating floras with the Miocene became a habit with him, and was always justified by percentages. He persistently ignored Eocene floras, and it was only the stratigraphical and overwhelming palæontological evidence as to the position of the Dakota and other floras of America that led him to admit the Cretaceous age of the older dicotyledonous floras.

It was Heer's privilege to describe the floras of Greenland, and he called them Miocene. Had it fallen to Saporta's lot, he would possibly have assigned to them a Lower Eocene age, on account of the considerable number common to Gelinden, including the typical *M'Clintockia*, which had not then been found in any other formation. A student of our Reading flora would have assigned them to that age. The Greenland flora has in its turn served to identify the Mull and the Antrim floras as Miocene, and must have absorbed the Gelinden flora and the American floras, had stratigraphical evidence not intervened and made this impossible. Not the least remarkable fact about these determinations is, that wherever the stratigraphical evidence is *nil*, as at Antrim, Mull, and Bovey, the floras are Miocene; but where there is stratigraphical evidence, we hear of few Miocene floras to the west of Switzerland.

Before quitting the subject, it is well to revert to the danger of determining the ages of fossil floras in remote parts of the world by comparing and estimating the percentages common to those of Europe. Not only have we to keep in mind the similarity that dicotyledonous leaves belonging to different genera bear to each other, a likeness increased by the process of fossilization where the matrices are similar, but the fragmentary condition of the specimens usually brought from distant countries. In the first five volumes of the Arctic flora hardly a perfect dicotyledonous leaf is illustrated, and it is most rare to find them collected with so important a character as the petiole complete. In addition to this, were we to take an armful of fallen leaves at random from each country, such as Siberia, Japan, Sumatra, Australia, New Zealand, Madeira, Scotland, France, Greece and the United States, and compare them together after the manner of palæontologists, is it likely that we should find grounds for supposing that they all belonged to floras growing synchronously? The fallacy of such reasoning is even more apparent when we realize that a considerable percentage of the species of even Eocene floras, including such unmistakable forms as *Osmunda Javanica*, are now living on the East Coast of Asia, for a comparison by percentages would make the existing and the Eocene floras contemporaneous. In like manner we have living Asiatic species at Mull and Antrim, living Australian species at Bournemouth and Sheppey. These must have migrated to or from their present habitats, and might be found imbedded anywhere along the routes they have passed over, and if so found might be of any age between the Eocene and the present day.

We are too accustomed to treat these floras as complete exponents of the vegetation of the past. They are, however, but mere fragmentary indications of what existed. The flora of Gelinden consists of, for instance, some 60 species, but only contains three Ferns and one Conifer. Can we suppose that Ferns and Coniferæ were not at least as richly represented then as now? And if we were well acquainted with the bulk of them, how entirely erroneous our inductions from the few we do know might appear. Bournemouth is a case in point, for on the right of the old river delta, of which the present cliffs are a section, the flora is completely different in character to that met with on the left. The latter is a flora of leafy trees, and had it alone been accessible, the climate might have been inferred to have been too temperate for the growth of Palms, for none are found in it. Thus an utterly different view of the character of the plant world of the Eocene period during the Middle Bagshot would be deduced by a student of the flora of the right bank, from that fairly deducible by a student of the left bank. But, extraordinary to tell, within a few hundred yards of the latter, still another completely different flora is found, in which occur Fan Palms in place of Feather Palms, *Araucaria Cunninghami*, *Eucalypti*, *Aroïds*, and a whole host of tropical Ferns. Even now, after years of collecting, new and astonishing plants are continually coming to light, such as *Hewardia regia*, a South American type of Fern, and

*Stenocarpus*, a purely Australian genus, as if to impress the danger of prematurely drawing inferences. Not deep below we have another completely different tropical flora on the Alum Bay horizon, with scarcely a type of plant in common to the horizon above; and again, separated in this district by only a few hundred feet, we might find the characteristic flora of the Reading beds with an utterly distinct assemblage, indicative of a temperate climate. In face of such amazing facts it is only possible to smile at the glib way in which temperatures and comparisons for every little handful of fossil plants are set out, and the physical features of the country which bore them reconstructed.

These remarks are not intended to discredit those who have laboriously worked at the task of deciphering fossil floras. They are simply meant to warn those who have to make use of the facts arrived at, that the conclusions and the inductions drawn from them are not based upon foundations as assured as those of other branches of geology and palæontology. They may or may not prove to be wholly or partially correct, but what we had best do for the present is to abstain from theorizing, and to devote ourselves to the work of deciphering, more especially those floras whose ages are definitely stratigraphically known, and by friendly intercourse and repeated comparisons of actual specimens, to ascertain beyond all dispute that a species means one and the same plant to each individual worker.

If at the same time it could be agreed that new species should not be founded on fragments so obscure and imperfect that no good specific characters can be obtained from them; that references to genera founded only on resemblance of foliage should be distinguished by a special termination; and that fossil plants found to be still existing should bear the name of the living plants; the science would rapidly command that consideration and respect to which its vast importance so well entitles it.

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## VI.—Notes on the Erosive Power of Glaciers, as seen in Norway.

By Professor J. W. Spencer, M.A., Ph.D., F.G.S.

1. DURING last summer it was my good fortune to visit the three largest snowfields in Norway, namely, Folgefond, at the head of Hardangerfjord, in Southern Norway, whose area is 108 square miles; the Jostedalsfond, two degrees to the northward, and beyond Sognefjord, whose area is 580 square miles, and the largest snowfield in Europe; and the Svartisen, of nearly equal area, extending from just inside the Arctic Circle for 44 miles to the northward. All of these snowfields send down glaciers to within from 50 to 1200 feet of the sea. These snowfields are not basins like those in the Alps, but are mantles covering the tops of the plateaux from 3000 to 5000 feet or more above the tide, from which great *cañons* suddenly descend to the sea, and extend themselves as fjords from 1000 to even 4000 feet in depth.

2. Many of the Norwegian glaciers are rapidly advancing. In their progress they do not conform to the surfaces over which they are passing, but are apt to arch over from rock to rock and point to point, especially as they are descending the icefalls. Thus are produced great caverns into which the explorer can often wind his way for long distances.

3. Beneath the glaciers of Fondal, Tunsbergdal, and Buardal, in the northern, north central, and south central snowfields of Norway, as well as under other glaciers, I observed many stones enclosed in ice, resting upon the rocks, to whose surfaces—sometimes flat and sometimes sloping steeply—they adhered by friction, and by the pressure of the superincumbent weight. Although held in the ice on four sides, with a force pushing downward, the viscosity of the ice, or the resistance of its molecules in disengaging themselves from each other in order to flow, was less than that of the friction between the loose stones and the rock, consequently the ice flowed around and over the stones, leaving long grooves upon the under surfaces of the glaciers. (The use here of the word 'viscosity' is in the sense of ice moving like a viscous body, irrespective of the cause.) The first observation made was at Fondalbræ, where an angular stone, whose section was 10 by 18 inches, rested upon the sloping face of smooth rock. For 20 feet below the stone, the under surface of the glacier was grooved by the moulding of the ice about the obstacle. This distance showed the advance of the glacier after the stone had come in contact with the rock, for it had evidently been completely buried at the lower end of the groove, before the ice had begun to flow about it. As the ice between the stone and the rock gradually disappears, the embedded stone does not suddenly cease to move but drags, until enough of its surface rests upon the rock to allow of friction between the two granitoid surfaces to overcome the viscosity of the ice, when the latter flows around the obstacle. Elsewhere an example of this action was seen. The knife edge of a wedge-shaped piece of gneiss was protruding beneath the ice and resting upon the rock. The front end of this stone had moved beyond the subjacent surface, whilst the posterior end was still upon it. Yet the sharpness of the edge had scarcely been blunted.

4. Abundant examples were found showing that the flowing of the ice about loose obstacles was quite the rule. Both large and small (even an inch in length), angular and rounded masses lying either upon the rock, or upon morainic matter, were sufficient to channel the bottom of an advancing glacier.

5. No blocks of rock were seen in the act of being torn loose from the floor or sides of the valley, and certainly there were no loose or solid masses being picked up by the advancing glacier.

6. At Tunsbergdalbræ, whose lower end is 1600 feet above the sea, a modification of the above-described phenomenon was seen. A roughly rounded boulder of 30 inches diameter was enclosed in the convex side of the glacier, which rose above it from 30 to 50 feet in height. It was resting upon a surface, sloping at 45°, and was held in place by the ice itself. As the surface of the stone, bearing upon

the rock, was small compared with that held in the ice, it should have been dragged along. But it was being rolled, as shown by the moulding of its form in the glacier, which was advancing faster than the stone was rolling down the steep slope. The pressure upon this stone could not have been merely that of the superincumbent ice, but a powerful component of the energy of a glacier descending 1500—2000 feet, as if the ice were moving more or less as a fluid. The energy upon our boulder was sufficient to crush it into one large and two smaller masses, together with stone dust. When seen these fragments had hardly begun to part company.

7. The abrasion of the solid rock by the fall of stones, and detached masses of ice and stones was illustrated at the locality just named. The two guides and myself succeeded in detaching a large boulder of about five tons weight, adjacent to the edge of the glacier. It went rolling and sliding down a hundred feet or more, tearing away great blocks of ice, which held a considerable amount of *débris*, and in its wake the rock was more or less crushed and scratched.

8. A further example of the ability of the ice to flow like a plastic body was shown in a cavern 400 feet higher than the end of the glacier, where the temperature was 4° C., whilst that outside was 13° C. Upon the *débris* of the floor rested a rounded boulder whose longer diameter was 30 inches. It could have been rolled over by one man. A tongue of ice, in size more than a cubic yard, was hanging from the roof, and pressing against the stone. In place of pushing the stone along or flowing around it, the lower layer of ice above the tongue had yielded, and was bent backward at right angles, as easily and gracefully as if it had been a thin sheet of lead, in place of one of ice a foot thick.

9. According to the experiments of Pfaff,[1] the temperature of ice has a great deal to do with its flow about obstacles. Below freezing-point, the movement is scarcely more than appreciable, whilst above that point, but not below, it may reach 28 inches a day or more. The conditions arising from the temperature beneath a glacier are more or less favourable to the movement of the ice, as the lower surfaces are never entirely below freezing-point, even in winter. Prof. S. A. Sexe found that the water flowing from a Folgefond glacier,[2] in February, 1861, had a temperature of 1° R., whilst that of the air was 7° R.

10. The movement or flow of the ice about detached stones has been observed by Prof. Sexe beneath the Buarbræ, and by Prof. J. W. Niles[3] beneath the Aletsch glacier. Prof. Sexe illustrates the sliding of the ice over a loose stone, which was wedged beneath the glacier by a projection of the rock. My observations were upon masses not held up by wedges, but upon surfaces often sloping downward. Although Prof. Niles did not record observations showing that there was definite movement of the stone, yet he concluded that

[1] Nature, Aug. 19th, 1875.
[2] "Om Sneebræen Folgefon," af S. A. Sexe.
[3] Am. Jour. Sc., Nov. 1878.

there was a differential movement of the ice and the block. Whatever differential movement there is beyond that referred to, it must be very inconsiderable even upon the inclined surfaces, and upon the horizontal plains it must be indefinitely small, as here even the movement of the ice is reduced to almost zero, as shown by the measurements of Prof. Tyndall,[1] upon the Morteracht, where the velocity of the surface, some distance from its end, was 14 inches, whilst that of the tongue of the glacier, as it reached the plain, was only two inches a day.

11. The most favourable condition for holding stones in ice as graving tools is low temperature, which impedes its progress, but this condition beneath the glacier does not generally exist. At higher temperatures the velocity of the glacier is not great enough to overcome its plastic movement and to drag along the detached blocks. However, when the whole mass of ice is charged with sand and stones, there is no doubt that polishing and some scratching are effected: but when there are only occasional fragments in the bottom of the ice, as is commonly the case, the erosion from the sliding ceases, as soon as the resistance due to friction between the stones and the rock equals that due to viscosity, which observation shows to be soon reached. Consequently we should not expect to find great troughs or grooves scooped out by the actual glacier. These I have not seen about the existing glaciers of Norway, which are not dependent upon atmospheric and aqueous erosion and the texture of the rock, although their surface may have been subsequently polished. Generally speaking, as shown in the valley behind the Fondal Gaard, where the glacier is nearly free from sand, and contains comparatively few stones, as well as at many other places, the surfaces of the subjacent crystalline rocks, although of the form of *roches moutonnées*, with angles mostly removed, are not smooth, but are as rough and as much weather-worn as similar rocks in warmer countries where no glaciers have been. Upon these surfaces it is often difficult to discover any scratches, even where present, for they are often so faint as to be only rendered apparent by moistening the rock. Even the faces of the hummocks are commonly unpolished. In other places, particularly at Tunsbergdalbræ, which contains much sand along the margin, the rocks are highly polished and but little scratched. One is everywhere surprised to find beneath the glaciers the paucity of glaciated stones, and in many terminal moraines they are scarcely if at all to be found.

12. The insufficiency of glaciers to act as great erosive agents is further shown at Fondal, where a mass of ice, 30 to 40 feet thick, abuts against a somewhat steep ridge of rock, 10 feet or less in height. In place of a stone-shod glacier sliding up and over the barrier, the lower part of the ice appears stationary (or else is moving around the barrier), whilst the upper strata bend and flow over the lower layers of ice.

13. When the barrier to the advance of a glacier is met with, whether composed of hard rock, or of morainic matter, the ice,

[1] Tyndall's "Forms of Water."

provided it be sufficiently high, flows over upon itself, yet when the sheet is no higher than the barrier, the lateral thrust may push it up somewhat. The best example of the consequences of such a condition is to be seen at Svartisen glacier, at the head of Holandsfjord, which descends to within 50 feet of the sea, where it ends in a morainic lake of considerable size, the northern side of which is filled with ice. The water of the lake rises, in part, to the level of the ice, or over it, where the waves of the lake are depositing sand upon its surface. Part of the ice is not less than 25 feet thick, and most of it is probably double that thickness. Some of the strata of the ice are pushed up and rest at 5° from the horizontal. But the interesting observations are at the end of the glacier, where it impinges against the morainic barrier. Being unable to advance, the lateral pressure has forced up an anticlinal ridge, or rather dome, in the ice, to a height of 15 feet, along whose axis there has been a fracture and fault. Upon this uplifted dome rests the undisturbed sand stratified perfectly conformable to the surface which was formerly just below the level of the lake. As the ice about the line of fracture melts, the sand falls over and leaves a sand cone, of which there were examples, one at the end of the lake, and two in the centre, but the *nuclei* of the mounds were of solid ice. By this lifting process, pockets of loose clayey sand were thrown on top of the morainic matter, producing thus the appearance of having been ploughed up by the glacier, to even several yards beyond its termination.

14. Nowhere is there apparently more ploughing action, and yet little or none to be seen, than at the Buarbræ, which is advancing rapidly against a high lateral moraine. There is a large ridge of stone upon a thin snout of the glacier, just as if the ice were pushing under the boulders or earth, which, however, it is not doing. The glacier has a steep convex margin, from 20 to 40 feet high, with many blocks and boulders upon it. These become detached, and rolling down upon the lower tongues of ice, leave a deep trough between the ridges thus produced and the side of the glacier, and delay the melting of the layer of ice beneath, which is too thin to do any undermining of the moraine.

15. An excellent illustration of a glacier advancing, without any ploughing action, over a moraine, and at the same time levelling it into a sort of ground moraine, was seen at the Suphellebræ. Here the glacier was moving up the slight elevation or moraine produced by the early summer retreat of the glacier, although advancing again in July. The lower surfaces of the ice tongues were furrowed by the loose stones of the soft incoherent water-soaked moraine, into which one's foot would sink when stepping upon it. The moraine was being levelled by the constant dripping of the water from the whole under surfaces of the advancing glacier.

16. This glacier of Suphelle is the most remarkable of its kind, being a *glacier rémanié*. From the Jöstedalsfond, which, near the head of Fjærlandfjord, is 3000 to 4000 feet high, the clear bluish ice and the consolidated snow fall over a precipice of dark rocks for

about 1000 feet, and at about 1500 to 2000 feet above the sea re-form into a glacier extending down into and nearly across the valley of Fjærland, for a distance of somewhat less than a mile, to a level of only 175 feet above the sea. The glacier is much crevassed and covered and filled with *débris*. In fact, it is the most dirt-laden glacier known—not excepting the Aar glacier in the Alps. These materials are wholly derived from the side of the mountain, and brought down by frosts, and more largely by the fall of ice as it dashes from one frost-cracked rock to another. One of these great ice avalanches I witnessed from the other side of the valley—fully a mile distant. Thousands of tons must have fallen at this time, but as the ice fell from rock to rock, it was converted into what, seen from the distance, appeared to be white dust.

17. There are no considerable streams from the upper glacier, but from the melting ice, below the fall, the volume of water laden with mud is large. As this glacier is not ploughing up but levelling down the inequalities of its bed of loose materials, we cannot suppose that the mud comes from any other than the dirt upon and within the ice, and that obtained by the dripping water as it levels the terminal moraine. This is only one of the examples everywhere to be seen showing the erroneous estimate of glacier-erosion, when based upon the amount of mud carried down by the streams flowing from the glaciers, for the *débris* is brought upon their surfaces by other than grinding action, and, as far as observation goes, it is not derived from beneath them, at least, to any great extent.

18. Although I have seen some of the sharp angles of the rocks at 2000—3000 feet above the sea, along the sides of the valleys, more or less rounded, yet the inequalities of the faces have not been generally removed by erosion of any kind. At numerous places in Norway as well as in other countries, hummocks of rocks rise above or out of the glaciers, as the ice flows around them at lower levels—these channels having been deepened not by glaciers but by sub-glacial streams.

19. Nowhere are the *roches moutonnées* so abundant as on the coast of Norway. In their more perfect form, they are not extensively developed along the coast more than 250 feet above the sea. At higher altitudes they are best seen about glacier-falls, farther up the valleys. But since the Pleistocene days, the coast has been raised several hundred feet, at least. The form of the hummocks is precisely like what may be seen in South-Eastern Missouri, and other states south of the line of northern drift, or like those described in Ceylon, Brazil, and other tropical countries, to which only are added the scratches. The forms of the hummocks must be principally attributed to the atmospheric erosion of the crystalline rocks, where the *débris* has been swept away by currents or by ice. We see them more frequently swept clean upon the coast of either cold or warm countries than in the interior, where the currents are only those from rain or local glaciers, for even the sweeping beneath the glaciers is principally effected by dripping waters or streams. Prof. Kjerulf, of the University of Christiania, than whom there is no better

authority, regards the production of hummocks and their glaciation up to a height of 600 feet upon the coast of Norway as the result of floating-ice.[1]

20. The absence of transported boulders and striations upon the surface of many parts of the high plateaux of Norway is doubtless, in part, attributable to the capacity of ice to flow over loose obstacles, and the frequent want of higher ridges to furnish material by their *débris* falling upon the ice, which might afterwards work through the mass.

21. The faith in glaciers as great erosive agents has been so severely shaken, that most geologists who personally study those still existing do not attribute to them much greater power than that of removing soft materials, or are even sceptical of this power—as, for instance, Prof. Penck of the University of Vienna, who has been misquoted as having proved their great potency.[2] To this scepticism, it seems to me that these notes must contribute, especially when applied to the hypothetical excavation or modification of great lake-basins, and the transportation of northern materials in the Boulder-clay over the broad plains of America, as there were no mountains of adequate height with peaks and screes to supply the detritus sufficient to furnish the surface of the glaciers with all the boreal material of the drift, which now covers half a continent.

University of Missouri, Feb. 1887.

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## VII.—On *Hemiphyllum siluriense*, Tomes.

By H. Alleyne Nicholson, M.D., D.Sc.,

Regius Professor of Natural History in the University of Aberdeen.

In the last Number of the Geological Magazine there is published a paper by Mr. Robert F. Tomes dealing with two Corals from the Silurian rocks of Britain. For the reception of one of these Corals Mr. Tomes proposes to form a new genus under the name of *Hemiphyllum*. The single species of this proposed genus he identifies, somewhat doubtfully, with the form described by M'Coy (Ann. Nat. Hist. ser. 2, vol. vi. p. 281, 1850) under the title of *Cyathaxonia silurienis*; and he therefore describes it as *Hemiphyllum siluriense*, M'Coy, sp., with a note of interrogation.

I wish, however, to point out, in the first place, that the description and figures given by Mr. Tomes of this Coral render it perfectly certain that he has had to deal with a species of the genus *Calostylis*, Lindstr., founded long ago, and rightly referred to a position among the *Eupsammidæ*, by Dr. Gustav Lindström (Öfversigt af Kongl. Vetenskaps-Akad. Förhandl. 1868, and Kongl. Svenska Vetenskaps-Akad. Handl. Bd. ix. 1870). The proposed genus *Hemiphyllum*, Tomes, cannot, therefore, be sustained, and the name must simply

[1] Discourse before Meeting of Scandinavian Naturalists, Copenhagen, 1873.
[2] Geological Magazine, April, 1883.

be added to the long list of synonyms which already afflict the students of Palæozoic Corals.

In the second place, with regard to the *specific* determination of Mr. Tomes's Coral, it may at once be unhesitatingly stated that it has no relation of any kind to the form which M'Coy described as *Cyathaxonia siluriensis*. Of all the troublesome little cup-corals of the Silurian and Devonian rocks, I do not know one so clearly marked off and so easily recognized by its general aspect and characters as this rare form, and I am at a loss to imagine what should have led Mr. Tomes to suppose that he had to deal with examples of this species. That *Cyathaxonia siluriensis*, M'Coy, is not a species of *Cyathaxonia*, Mich., but that it is truly referable to the genus *Lindstræmia* has been formerly pointed out by Mr. R. Etheridge, jun., and myself (Mon. Sil. Foss. Girvan, p. 82, 1880). Our determination was based simply upon a macroscopic examination of the species; but I have since then examined the species by means of thin sections, and have completely confirmed our reference of it to *Lindstræmia*. I shall take an early opportunity of publishing a description and figures of its internal structure.

The *Hemiphyllum siluriense* of Mr. Tomes is not, however, referable to any recorded species of the genus *Calostylis*, Lindst. So far as I am aware, only two species of *Calostylis* have been previously described, both of these being from the Silurian rocks. One of these is *C. denticulata*, Kjerulf, fully described and figured by Lindström, first under the name of *C. cribraria*, and subsequently under the above title (*loc. cit.* supra). The second species was described, from British specimens, by Mr. R. Etheridge, jun., and myself (Mon. Sil. Foss. Girvan, p. 65, pl. v. figs. 2—2*c*, 1880), under the name of *C. Lindströmi*. Neither of these species agrees in its characters with the form which Mr. Tomes has had under examination. This I am the better able to affirm as I have not only fully examined the two recorded species of *Calostylis*, but I am well acquainted with the species here in question. My friend, Dr. George J. Hinde, in fact, presented me with specimens of this form, from the Wenlock Shales of Buildwas, some years ago, since which time they have lain in my cabinet with the MS. name of *Calostylis breviuscula* appended to them; but I have never found time to publish a description of the species.

Lastly, with regard to the Corals to which Mr. Tomes refers under the name of *Cyathaxonia Dalmani*, E. and H., I may point out that Dr. Lindström long ago recognized that the Coral so named did not belong to the genus *Cyathaxonia* at all. The correctness of this view was demonstrated by Mr. R. Etheridge, jun., and myself (Mon. Sil. Foss. Girvan, p. 84, fig. 4), who showed that *C. Dalmani*, E. & H., belonged properly to the genus *Lindstræmia*, Nich. and Eth. jun., a determination which has been since accepted by Dr. Lindström himself (List of the Fossils of the Upper Sil. Form. of Gotland, p. 19, 1885).

## NOTICES OF MEMOIRS.

L'Excursion de la Société géologique en Bretagne. Par M. De Lapparent. Revue Scientifique, 8 Janvier, 1887.

THIS is an article upon the excursion already described in the February Number of this Magazine. It gives a general view of the geological features of the Armorican peninsula, the igneous and metamorphic rocks occurring there, and certain questions hitherto controverted on which evidence regarded as conclusive was produced. Among these were the age of certain granites, the causes of the metamorphism in certain localities, and the nature of the passage from Cambrian strata to Silurian. As to this last, the sections in the Bay of Douarnenez and the succession seen at Gourin are said to present concurrent indications that in this district the transition is conformable and continuous.

Upon the Archæan question the author expresses decided opinions. To think that the crystalline schists can be excised from the chronological succession, and to regard them as capable of being produced out of any strata, whatsoever their age, is, he says, "an extension of the idea of metamorphism which is altogether a misuse of it." "The facts observed in Brittany seem fatal to this view." E. H.

## REVIEWS.

Geological and Natural History Survey of Canada. Annual Report (New Series), Vol. I. Accompanied by an Atlas of Maps. Royal 8vo. pp. ix. and 798. With Geological Maps, Plans, Plates, and Woodcuts. (Montreal, 1886.)

THE present volume ushers in a new series, and although entitled Report for 1885, it includes work done in previous years, and in the early part of 1886. It begins with the customary "Summary Report" ("A." pp. 1A—108A[1]) by the Director, Dr. A. R. C. Selwyn, F.R.S., F.G.S. This contains an excellent résumé of the operations of the Geological Staff in the field, and of the work carried on at head-quarters (Ottawa) in the museum, laboratory, and library.

The succeeding reports fully sustain the deservedly high reputation so long enjoyed by the Canadian Survey. Many important contributions to the history of the geology and resources of the country are contained in them; showing how work has been prosecuted "over portions of every province and territory in the Dominion, from Nova Scotia to the west coast of Vancouver Island."

Among the varied duties that now fall to the lot of the Dominion geologists are included the collection of specimens illustrative of the Zoology, Botany and Ethnology of the tracts explored, in addition to their Geology and Lithology.

Messrs. Whiteaves and Ami undertake the palæontological and zoological work, with the occasional assistance of eminent English

[1] The Reports being also published separately, each is distinguished by a letter or letters in the pagination.

and American "specialists." Professor Macoun (Botanist to the Survey) reports upon the plants collected, while Sir J. W. Dawson frequently lends his valuable assistance in the department of palæobotany. Messrs. Hoffmann and Adams carry on the work of the chemical laboratory. The staff now numbers 50, viz. 34 "professional," and 16 "ordinary" members.

Much attention is naturally bestowed upon the mining industries of the country. In 1885 a survey was commenced by Mr. Bowman and assistants of the gold-mining region of Cariboo in the interior of British Columbia. This district, comprising an area of 50 by 75 miles, has yielded in the past twenty-five years about thirty million dollars of gold by placer mining. The various mining centres in the Eastern Townships (Province of Quebec, east of the St. Lawrence) were visited by Messrs. R. W. Ells and N. I. Giroux. The minerals obtained are gold, silver, iron, copper, and asbestos. In the last of these a flourishing trade is carried on. The copper deposits are also extensively worked. Most of these minerals find a market in the neighbouring States.

Leaving the Summary Report, of which we have given but a very brief sketch, let us now turn to the reports of the field corps, which make up the bulk of the volume.

Report B. (pp. 7B—167B), by Dr. George M. Dawson, "is intended as a preliminary geological and general account of that portion of the Rocky Mountain range included between the 49th parallel on the south and the upper waters of the Red Deer River (about lat. 51° 30′) to the north. The Rocky Mountain range proper, in this region, is definitely limited to the south-west by the great Columbia-Kootanie Valley, which separates it from the Selkirk and Purcell ranges, while to the north-east the edge of the Palæozoic rocks may be regarded as its boundary. The width of the range thus naturally outlined is about fifty miles. The length of the range here treated of in a north-west and south-east bearing is about 200 miles, while the approximate total area covered by this report and the accompanying map is about ten thousand square miles." The map spoken of is geologically coloured, and is on a scale of five miles to one inch. It contains marginal notes and sections.

Beginning with an account of former geological and geographical explorations of the region, amongst which the most important were those of Captain Palliser, Dr. Hector, and Mr. Bauerman, the author proceeds to describe its orographic features. He explains that the so-called Rocky Mountains are divisible into four great systems, which are from east to west as follows:—"(1) The Rocky Mountains proper; (2) Mountains which may be classed together as the Gold Ranges; (3) The system of Coast Ranges sometimes improperly regarded as a continuation of the Cascade Mountains of Oregon and Washington Territory; (4) A mountain system which in its submerged parts constitutes Vancouver and Queen Charlotte Islands."

Taking up the geology of the district surveyed by Dr. Dawson, we find that the Cambrian is the basal formation, and consists of "quartzites, and quartzitic shales passing into argillites, and occa-

sionally including limestone or more or less calcareous or dolomitic materials and conglomerates. Sheets of contemporaneous trap also occur, probably at several horizons."

An instructive section of the Cambrian formation, with a thickness of about 3000 feet, was met with near Waterton Lake, and in the eastern part of the South Kootanie Pass. But between the latter and the Flat-head River these beds were calculated to have a minimum thickness of 11,000 feet, and this "included neither the summit nor the base of the series."

The similarity both as respects their lithological characters, and the general absence of life, of the Cambrian of this part of the Rocky Mountains, to that of the Wasatch Mountains in Utah, and to the same rocks of the Chuar and Grand Cañon Groups of the Colorado Cañon in Arizona, is pointed out by the author. Mr. C. D. Walcott (Amer. Journ. Sci. vol. xxvi. p. 437) has suggested that the absence of the Lower Cambrian Fauna in the western part of the Continent of North America may be due to a land barrier having existed at that time between the eastern and western portions of the continental area. But Dr. Dawson remarks that "the body of water in which the lower portion of the rocks here described were deposited was a basin separated from the ocean, and, occasionally, if not continuously, in the condition of a saturated brine, and this may in itself explain the absence of life of any kind, at least in this particular region."

Between the Cambrian series and the "Devono-Carboniferous" rocks which succeed, and rest unconformably upon them, there is an interval which is in part at least filled up in the north-western portion of the area by a mass of beds of "Silurian and possibly also of Cambro-Silurian [Ordovician] age."

The "Devono-Carboniferous" series attains an estimated thickness of from one thousand to four thousand feet and "forms many of the most prominent ranges and mountain masses." This great limestone series is overlaid unconformably by rocks which are upon stratigraphical, in the absence of palæontological, evidence deemed to be of Triassic age, and are here "probably the northern limit of a great Triassic mediterranean sea, which extended far to the southward in the western part of the present continental area."

The Cretaceous rocks are next in ascending order, and belong to the lower division of that group, here named by Dr. Dawson the "Kootanie Series," though showing, according to Sir J. W. Dawson, who examined the plants, consisting of Ferns, Cycads, and Conifers (with one exception the only fossils collected), affinities with the Jurassic of the Amur country of Siberia, and of the Lower Cretaceous of Greenland, as these floras have been described by Heer."

The sandstones, shales, and conglomerates composing the Kootanie Group are estimated to be about 9000 feet in thickness.

Important Coal-bearing rocks occur in this series, and their distribution is depicted upon a coloured geological map of part of the "Cascade Coal Basin." The coal is an anthracite of excellent quality, and its proximity to the Canadian Pacific Railway line will cause it to be soon turned to account.

The chief development of the Coal-bearing rocks is in the valley of the Cascade River, a tributary of the Bow, where the Cretaceous rocks form a "long, narrow, synclinal fold, which, owing to the immense pressure from the south-westward, has been bodily overturned in the opposite direction; the mountain range on the south-west side being composed of an anticlinal of the limestone series, similarly compressed and folded over on the Cretaceous rocks."

Volcanic beds (ashes and agglomerates) occur at an horizon not far above the summit of the Kootanie Group, which would make them of the age of the Dakota period. Their maximum thickness is estimated at 2200 feet.

In a "provisional general section" of the Cretaceous beds of the mountains of the area explored, their thickness is put down at 13,350 feet, making with that of the Foot-hills and Plains (7490 feet) a maximum thickness for the Cretaceous of the region of 20,840 feet.

Upon the subject of economic minerals Dr. Dawson informs us that the recognized gold-mining district is "Wild Horse Creek," "but nearly all the streams flowing into the Columbia-Kootanie valley contain more or less alluvial gold, which should be sought in those parts of the district which are based on the slaty zones of the Cambrian."

The author was much struck with the grandeur and beauty of the scenery of the mountains, and the excellent engravings with which the report is illustrated enable the reader to realize in some degree the physical features of this magnificent tract of country.

Mr. R. G. McConnell's Report (pp. 5c—78c) treats of the geology and resources of the Cypress Hills, Wood Mountains, and adjacent territory, embracing part of the district of Assiniboia, and covering an area of about 31,000 square miles. It is accompanied by a geological and topographical map of the district, together with photographic and other illustrations.

The most interesting result of Mr. McConnell's researches from a geological point of view was the discovery of thick deposits of conglomerates of Miocene age, covering Laramie beds, which have by this means escaped destruction. The Miocene rests unconformably on the Laramie, as a rule; but in some places it overlaps and comes in contact with the Fox Hill beds beneath.

The Miocene beds are characterized by the great quantity of water-worn pebbles in them, derived from the quartzite formations of the Rocky Mountains. These beds cover an area of nearly 14,000 square miles, capping the more elevated parts of the plateaux from the west end of the Cypress Hills to the east end of Swift Current Creek plateau, a distance of 140 miles.

Numerous invertebrate fossils were collected in the Cretaceous beds, and remains of Reptilia (*Testudinata*) and Mammalia (*Bunotheria* and *Perissodactyla*) in the conglomerates. The Vertebrates furnish the subject of a separate report by Prof. E. D. Cope (Appendix i. pp. 79c—85c).

Mr. Andrew C. Lawson's report (pp. 5cc—151cc) is "On the Geology of the 'Lake of the Woods' Region, with special reference to the Keewatin (Huronian?) belt of the Archæan Rocks."

The beds examined consist of a belt of schistose rocks which runs through the granitoid gneiss across the northern parts of the Lake of the Woods, and has been hitherto regarded as of Huronian age. Mr. Lawson, however, considers these rocks to be older than Sir W. E. Logan's typical Huronian. His reasons for coming to this conclusion are based mainly upon the lithological characters of the rocks. Thus he finds (1) that Logan's typical Huronian is essentially a quartzitic series, whereas in the Lake of the Woods series quartzites form a very small proportion of the rocks. (2) Logan's series is characterized by bedded limestones, but there are none of these in the Lake of the Woods series. Further, the basal conglomerate of Logan's Huronian on Lake Temiscamang is described as holding pebbles and boulders, of the subjacent gneiss, from which they appear to be derived. Mr. Lawson holds that the Lake of the Woods rocks are not basal conglomerates, but "agglomerates" of volcanic origin, the fragments in them being frequently sharply angular.

Taking these and other facts into consideration, Mr. Lawson is of opinion that it is best to regard the Lake of the Woods rocks, at least provisionally, as a distinct series, for which he proposes the name of "Keewatin"[1] series, and adds that they "may be taken as representative of an important division of the Archæan, extensively developed in parts of the great Laurentian area."

Mr. A. P. Low's report (pp. 5D—55D) consists of geological and meteorological observations in the region of Lake Mistassini.[2] It was found by this explorer that with the exception of the comparatively small areas of Huronian and Cambrian rocks, in the vicinity of Lake Mistassini, the Laurentian gneisses and associated rocks occupied the whole country from the Gulf of St. Lawrence to James' Bay, along the route taken by the expedition.

Appendices I., II. (pp. 34D—44D) of the report contain lists of birds and of plants collected at Lake Mistassini, and along the banks of the Rupert River.

Dr. Robert Bell's report (pp. 5DD—27DD) contains brief observations on Geology, Zoology, and Botany, made in his capacity as Geologist and Naturalist on board H.M.S. "Alert," on the Second Expedition to Hudson's Strait and Bay, sent out by the Government of Canada in 1885.

The opportunities for gathering information were necessarily limited, and advantage had to be taken of stoppages for the landing of supplies, etc., to make a few rapid notes. The report embodies the results of the geological investigations of previous years, dating from 1870.

Hudson's Bay, which has an area equal to about half that of the Mediterranean Sea, occupies the centre of a wide depression in the great Laurentian area. The Laurentian system of rocks prevails

[1] The Indian name for the North-West, or the North-West wind, applied to the district within which the rocks occur.

[2] Formed from two Algonquin words signifying "big-stone," and so called because of the large boulders of gneiss that strew the west shore of the lake.

everywhere in this region; but Palæozoic strata occur in many of the islands in Hudson's Bay, and probably extend over much of its bed. Rocks of volcanic origin were observed in the north-western part of the Bay.

The report by Mr. R. W. Ells (pp. 5E—71E) gives an account of the geological formations in South-Eastern New Brunswick, and in Cumberland and Colchester counties of the adjoining province of Nova Scotia.

The prevailing rocks of this area are the Pre-Cambrian or Huronian (?), the Carboniferous and Permo-Carboniferous. The Pre-Cambrian rocks are typified in the "Cobequid Series," which underlie unconformably the iron-ore belts flanking the Cobequid mountain range on the south. The Carboniferous system is represented by the three divisions, Upper, Middle, and Lower, and an elaborate description of each of these is contained in the report. The Spring Hill area was especially examined for the purpose of determining the extension of the thick coal-seams. The famous South Joggins Coal-measures, made historical through the labours of Logan[1] and Dawson,[2] are briefly described by Mr. Ells.

The report concludes with a reference to the economic minerals of the region surveyed. These include Coal (by far the most important), Iron, Copper, Gypsum, etc.

A coloured geological map on a scale of four miles to one inch accompanies the report.

Professor L. W. Bailey contributes a report (pp. 5G—30G) upon portions of Northern and Western New Brunswick. This also is illustrated by a geological coloured map, in which the orographic features of the region are delineated. It is upon the same scale as that of Mr. Ells.

The following geological systems are embraced in the region examined:—

| | |
|---|---|
| Carboniferous. | Cambro-Silurian (Ordovician). |
| Devonian (?). | Pre-Cambrian. |
| Silurian. | Crystalline rocks, including granite. |

The Carboniferous is of limited extent, and consists of the Millstone Grit, and the lower or marine beds of the system.

Much of the region is too densely wooded to admit of the examination of the underlying rocks, and their boundaries are therefore difficult to define with accuracy. Eruptive rocks in the form of dykes and intercalated masses are met with in many parts of the Silurian area, notably in the gorge above the Falls of the Aroostook river, close to the boundary-line of the State of Maine. Connected with these igneous and trappean overflows are innumerable faults, and the Silurian rocks are everywhere twisted and folded.

To the south of these rocks portions of the country are occupied by metamorphosed strata, penetrated by great masses of intrusive granite, supposed to be of Cambro-Silurian age, while other strata, apparently connected with these last, furnish in their fossil contents satisfactory evidence for referring them to that horizon.

[1] Report, 1845. [2] Acadian Geology, 1868.

The Pre-Cambrians consist typically of crystalline felsites, mostly obscurely stratified; and hard fine-grained syenites. Intrusive masses of igneous rocks also occur in the Pre-Cambrian area.

Mr. R. Chalmers furnishes a preliminary report (pp. 5 GG—58 GG) on the Surface Geology of New Brunswick, in which he describes the superficial deposits as consisting of "Alluviums, or Recent Deposits," and "Stratified Sands, Gravels and Clays." The topographical features of the Province, agricultural character, forests, etc., are also particularized, and a table of glacial striæ and a list of Post-Tertiary fossils are added.

Report K (pp. 5K—15K) by Mr. Eugène Coste, Mining Engineer, contains valuable observations on "Mining Laws and Mining in Canada," in which the writer attributes the failure of so many mining schemes in the Province of Ontario and Quebec and in the north-west territory to the defective state of the laws governing such undertakings.

Speculators are allowed to "purchase very cheaply large tracts of 'mineral lands,' which they are not compelled to work, and which they hold, against the interest of the mining industry and of the country, awaiting fabulous prices for them, and so preventing *bona fide* working companies from developing them."

To remedy this deplorable state of things, Mr. Coste proposes that national mining property should be submitted to an administration similar to that which is in force in France, Prussia, Austria, and other European countries. He formulates a series of "principles which should be followed in determining the conditions under which mining rights should be acquired and maintained." These relate to the leasing of mining property, the prevention of monopoly of mining rights on too large an area of land; penalties for insufficient working of mining property; regulations concerning the purchase of a sufficient extent of land for the surface requirements of the mine, and finally, the due inspection of mines by government officers.

The concluding report (pp. 1M—29M), by Mr. G. Christian Hoffmann, assisted by Mr. Frank D. Adams, contains a record of assays and analyses carried out in the Laboratory of the Survey, attention having been devoted chiefly to such minerals as promised to be of economic value.

A general Index to the volume completes this large and valuable accession to our knowledge of the physical geography, geology and material resources of Canada. ARTHUR H. FOORD.

## REPORTS AND PROCEEDINGS.

### I.—The Geological Society of London.

1.—Annual General Meeting, February 18, 1887.—Prof. J. W. Judd, F.R.S., President, in the Chair.

The Secretary read the Reports of the Council and of the Library and Museum Committee for the year 1886. The Council stated that they had to congratulate the Fellows upon a continuation of the

improvement in the state of the Society's affairs, to which they had the satisfaction of calling attention last year, although they regretted that they could not announce any increase in the total number of Fellows. The number elected during the year was 41, and the total accession was 46; while the losses by death, resignation, etc., amounted to 48, making an actual decrease of 2 in the number of Fellows. Nevertheless the number of contributing Fellows was increased by 2. The Balance-sheet showed an excess of Income over Expenditure during the year of £390 5*s.* 9*d.* The Council's Report further announced the awards of the various Medals and of the proceeds of the Donation Funds in the gift of the Society.

In presenting the Wollaston Gold Medal to Mr. J. W. Hulke, F.R.S., the President addressed him as follows:—

Mr. Hulke,—It is a very pleasant duty which I am called upon to perform in presenting you with the Wollaston Medal, as a recognition of your great services to the study of Vertebrate Palæontology. A member of that honoured profession which has given to Geology—and especially to the biological side of our science—so many diligent and accurate students, you have succeeded, in spite of the labours and anxieties incident to a very active career, devoted to the alleviation of human suffering and the training of others for the same duties, in finding time for very valuable researches among those wonderful forms of Reptilian life which characterize the Mesozoic period. Your hardly-earned vacations have been spent in the search of fossil bones among the mud-flats of Dorsetshire and the sandy cliffs of the Isle of Wight; and in this way you have acquired an exceptional amount of knowledge concerning the exact geological horizons and the mode of occurrence of the fossils you have so admirably described. As by successive discoveries you have been able to add new details to your restoration of the bony framework of *Iguanodon*, you must have experienced a joy akin to that of Creation! But though you are best known to the world by those osteological researches, those who, like myself, have had the happiness of being associated with you in the work of this Society, have discovered how wide is the knowledge, how catholic the sympathy, and how keen the interest with which you follow all the manifold developments of our Science.

Mr. HULKE, in reply, said:—Mr. President,—I cannot find words adequately to express how highly I value the distinction which the Council has this day, by your hands, conferred upon me. The pleasure I experience in receiving it is in no small degree increased by the words of approbation which have fallen from your own lips. The Wollaston Medal is so truly great a prize, and the work I have done to merit it has appeared to me so little in comparison with that accomplished by the long roll of illustrious men on whom in past time it has been bestowed, that I have fancied that (as occurred to Sir Philip Egerton on a similar occasion) in awarding it to myself the Council may also have desired to mark the recognition of the labours of those who, whilst not devoting the chief part of their time and energy to the culture of that branch of Natural Science for the advancement of which our Society exists, yet endeavour in their leisure hours to do what in them lies to add to our common stock of knowledge. To you, Sir, to the Council, and to the Fellows, I tender my warmest thanks.

The President then presented the Balance of the Proceeds of the Wollaston Donation Fund to Mr. Benjamin N. Peach, F.G.S., and addressed him as follows:—

Mr. Peach,—In addition to your services to science as an officer of the Geological Survey of Scotland—and how important those services have been every geologist in recent years has had an opportunity of judging—you have, in conjunction with your colleague and friend, Mr. Horne, devoted your holidays to arduous labour in studying the geology of the Orkneys and Shetlands. Both the glacial and the volcanic phenomena of those islands have been admirably elucidated by your joint researches. But besides your work in the field you have devoted much attention to palæontological investigations; and your discoveries concerning the nature of

the Carboniferous Arachnids and their allies have justly excited very great interest. To aid you in the prosecution of such studies the Proceeds of the Wollaston Donation Fund have been awarded to you, and I feel sure that one circumstance in connexion with this Fund will make the award specially welcome to you. In the roll of names of those who have in previous years received this distinction, will be found one, honoured alike by you and by us, that of your lamented father, Mr. Charles Peach.

Mr. PEACH, in reply, said:—Mr. President,—I desire to record my cordial thanks for the honour now conferred upon me. The pleasure derived from the pursuit of the researches indicated by you has more than compensated for my labour. It is, however, an additional gratification to me to know that my investigations have been deemed worthy of recognition by the Council of this Society.

The President next presented the Murchison Medal to the Rev. P. B. Brodie, M.A., F.G.S., and addressed him as follows:—

Mr. Brodie,—Never probably has an award of this Society been made to one who can look back upon so long a record of faithful services to Geology as yourself. It is now 54 years ago since you became a Member of this Society, at a time when the Founder of the Medal which has now been awarded to you occupied the Presidential Chair. At the date of your election the 'Principles of Geology' had but just appeared, while Sedgwick and Murchison had not even commenced their researches among the Palæozoic rocks of Western Britain. A pupil of the great Cambridge professor and infected with his enthusiasm, you soon began to contribute to various scientific journals, our own among the number, and in 1845 your valuable 'History of Fossil Insects'—the first treatise of the kind published in any language—made its appearance. A dweller in the provinces, you have shown how the advancement of our Science may best be promoted under those conditions; and in the field-clubs and local societies which have done so much for the study of geology in the West of England, where your home lay, you have long been a prominent and very active worker. Your published papers on a variety of subjects amount to more than 50, and only last year we were glad to welcome a fresh contribution from your pen, and to hear your clear exposition of it, as you stood before us with eye undimmed and with natural force unabated. The Council of this Society have adjudged you to be a worthy recipient of the Medal founded by their President of 1833.

Mr. BRODIE, in reply, said:—Mr. President,—I receive, Sir, this mark of the approbation of the Council with very great pleasure and grateful thanks; and it was more gratifying because it took me quite by surprise. After searching the rocks for more than half a century, and having been a Fellow of this Society for 53 years, it might be expected that I should have done more to enlarge our knowledge of geology; but of course my time was not entirely at my own disposal in this respect, and I could therefore only study Natural Science in the closet and the field during hours of leisure. As a proof that I have not been altogether idle, I have made during that time a large collection of fossils, numbering twenty-three thousand specimens, numbered and arranged, more or less illustrating every formation in the British Isles. But of course a mere collection of fossils, though having a certain value, is of little worth without an accurate knowledge of the rocks and their organic contents.

The award of the Murchison Medal is especially agreeable to me because I have had many pleasant and instructive days in the field with that distinguished geologist; but I do not forget that at Cambridge I was a pupil of the illustrious Sedgwick, to whom I owe a lasting debt of gratitude for the kind help and encouragement which that great and good professor was ever ready to give to any student anxious to learn. In after years, I can with pardonable pride speak of him as my friend. When I made some of my earlier discoveries of fossil insects and other organisms in the Wealden Purbecks in the Vale of Wardour, I received a letter from him in which he said, "you have made a good hit, go on and prosper," and this medal shows that I have so far done so. It is now more than half a century since I was admitted a Fellow of this Society, just before I went to college, and I know that some hesitation, and very properly, was felt whether I should take up geology to any good or useful purpose. But my kind proposer Mr. Clift, the able Curator

of the College of Surgeons, to whom I was well known, and where I often went as a student, would not give me up ; and this proof of the Society's favour just received shows that he was not altogether mistaken.

In my younger days, when I resided in London, I was a regular attendant at the meetings of this Society, then held in Somerset House, where I was a humble but (I hope) not inattentive listener to the papers read and the discussions which followed, and I recall with pleasure the many intellectual combats between the geological giants of those days. I regret that distance from London and the higher duties of my profession prevent my attending our meetings so often as I could wish ; but though now a septuagenarian, I am thankful to say that I can still hammer the rocks, and that my zeal and love for the noble science we all love so well has not abated ; but I fear I shall not be able to do much more to elucidate their history, though, if younger, this Medal would encourage me to make still further efforts ; and my chief regret is that, for reasons stated, I have not been able to do more to deserve the honour which the Society has kindly conferred upon me. I can only hope that the Society will pardon me for saying so much about myself.

**In handing the Balance of the Proceeds of the Murchison Geological Fund to Dr. Henry Woodward, F.R.S., for transmission to Mr. Robert Kidston, F.G.S., the President said :—**

Dr. Woodward,—The balance of the Murchison Fund has been awarded by the Council of the Geological Society to Mr. Kidston, to aid him in his important investigations among the fossil plants of the Palæozoic period. Mr. Kidston's great knowledge of the extensive literature and the complicated synonymy of these forms is borne witness to by the valuable catalogue which he has prepared under your superintendence, and which was issued only a few months ago by the Trustees of the British Museum ; a large number of remarkable memoirs have also shown his capacity for dealing with this difficult and intricate subject. In seeking to extend our knowledge of the earliest forms of plant-life, Mr. Kidston seems determined to leave no museum unvisited and no stone unturned, if perchance it should be found to exhibit any traces of an ancient vegetation. I will ask you to convey to Mr. Kidston, with this award, the hope of the Council that it may be of some assistance to him in enabling him to prosecute his researches.

Dr. WOODWARD, in reply, said :—Mr. President,—It is with much pleasure that I am permitted to act as Mr. Kidston's representative here this day, and to receive for him, at your hands, the award of the Murchison Donation Fund. I am sure Mr. Kidston would, had it been possible, have been present in person to receive the award. He writes as follows :—"I desire to express my thanks to the President and Council of the Geological Society for the honour they have conferred upon me in acknowledging my labours in Fossil Botany, an honour which I beg to assure them I fully appreciate ; it is one which will act as a stimulus in my future investigations in Vegetable Palæontology. My aim has always been most carefully to work out our Palæozoic flora, and in this spirit I hope to continue my labours, trusting that the results may be of use to others."

**The President then handed the Lyell Medal to Prof. T. G. Bonney, D.Sc., F.R.S., for transmission to Mr. Samuel Allport, F.G.S., and addressed him as follows :—**

Prof. Bonney,—It is to me an especially gratifying circumstance that it falls to my lot to deliver into your hands for transmission to Mr. Allport the Lyell Medal for the present year. Mr. Allport commenced the microscopical study of rocks at a time when the workers in that department of science were comparatively few, and when the road he had to travel was encumbered with difficulties and stumbling-blocks which have now been, to a large extent, removed by the labours of many earnest and patient workers. It was at that time my good fortune to know him, and to have frequent opportunities of admiring the perseverance and energy with which he carried on his researches. You have yourself from this chair paid a warm and well-merited tribute to the generosity with which, at that time, he was always ready to assist his fellow-workers. The establishment of one very important principle will always be associated with Mr. Allport's labours, namely, that the apparent differences between the igneous rocks of widely different geological periods are, to

a great extent, due to the changes which the constituent minerals of the older rock-masses have undergone since their original formation. His classic papers on the Archæan rhyolites of Shropshire and the Carboniferous dolerites of various parts of this country furnish the clearest evidence of the truth of this principle, and in several thoughtful and logical essays he has very ably enforced it. On a great variety of other questions connected with Petrology his researches have added largely to our knowledge; and the fine collection of rock-sections now in the National Museum, which were made by his own hands, bear striking testimony to his industry and skill.

Prof. BONNEY, in reply, expressed his regret that Mr. Allport was unable to be present to receive this Medal from the hands of the President, but said that he found some consolation in the fact that he had thus an opportunity of most heartily endorsing what had been said by the President as to the great value of Mr. Allport's own work, and of the kind assistance which he was always so ready to afford to his fellow-labourers in the field of Petrology. Prof. Bonney added that he should best thank the Society by reading to them a letter received from Mr. Allport, in which that gentleman wrote as follows:—"I much regret to inform you that I shall be unable to attend the Anniversary Meeting of the Geological Society in consequence of the very unsatisfactory state of my health. I venture, therefore, to request that you will kindly express to the Council my very grateful sense of the honour they have conferred upon me by the award of the Lyell Medal. It is, I assure you, most gratifying to me that the name of Sir Charles Lyell should be associated with this award; for I have not only ever regarded his character and scientific method with the greatest admiration, but it is undoubtedly to the study of his works that I am chiefly indebted for what little knowledge I possess of the principles of geological science."

The President next presented the Balance of the Proceeds of the Lyell Geological Fund to the Rev. O. Fisher, M.A., F.G.S., and said:

Mr. Fisher,—The Council of the Geological Society has awarded to you the balance of the Lyell Fund, in recognition of your great and long-continued services to our science. Nearly forty years ago you commenced your well-known stratigraphical investigations among the Newer Jurassics of Dorsetshire and the Older Tertiaries of the Isle of Wight, your attention being subsequently directed to the Pliocene and Post-Tertiary beds of East Anglia. At a very early period in your career a predilection for the great problems of Physical Geology began to manifest itself; and for dealing with such problems your mathematical training gave you obvious advantages. In these researches, however, which have been recorded in a number of separate memoirs, worthily crowned by the publication six years ago of your "Physics of the Earth's Crust," you have always maintained a just estimate of the proper sphere and necessary limitations of the mathematical method of treatment as applied to such problems. Speaking of the processes you have chosen to employ, you truly remark in the preface to your well-known work, "When it is recollected that, for the most part, we can assign only very hypothetical values to our symbols, it would be affectation to seek close results, which would, after all, have no greater value than those which claim to be only distant approximations." In you we rejoice to see that the geologist has not been altogether lost in the mathematician, and that you have always kept in mind in your researches the weakness no less than the strength of the mathematical method.

Mr. FISHER, in reply, said:—Mr. President,—It is no small gratification to me that the Society, through its Council, has expressed approbation of what I have done in the favourite study of a long life. I commenced geologizing almost before I can remember, when my uncle, the Rev. George Cookson, taught me to collect fossils in the cliffs of my native village of Osmington. My work in the field is now finished, and I geologize in my arm-chair out of my inner consciousness, but still, I hope, to some purpose. It appears to be rather these later attempts to unravel some of the physical riddles of our science (although my earlier observations in the field have not been forgotten) which have been thus handsomely recognized; and, indeed, for my own part I think what I have done in applying mathematical methods to these geological problems has been my most useful labour. Nevertheless I feel assured that my earlier work in the field has been of much service to me; for no one can pretend to grapple usefully with the great problems of geology who

has not personally studied the actual phenomena. It is in this respect that the greatest physicists of the day fail to give us the decided assistance which they might do had they a more accurate knowledge of the questions to be solved.

We pass on the torch from hand to hand. Some of the ideas which I have tried to work out were suggested by conversations with honoured friends long gone to rest—Sedgwick, Hopkins, Miller, Phillips, and others. May I hope that when some one now young, in this assembly, receives a similar recognition of a similar life's work, he may think of me as an intermediate link connecting him with those earlier workers?—a link which, whatever may be its intrinsic defects, and however inferior the metal, you have seen fit to gild with the balance out of the munificent legacy of the great Lyell.

In presenting the Bigsby Gold Medal to Prof. Charles Lapworth, LL.D., F.G.S., the President said :—

Professor Lapworth.—The late Dr. Bigsby established a Medal to be awarded to one "not too old for further work, and not too young to have done much." That you admirably comply with the latter qualification every geologist knows ; but that your age could possibly fall below the limit prescribed by the founder of this Medal, any one not personally acquainted with you might be pardoned for doubting. In studying the difficult, but, to geologists, very important group of the Graptolites, in utilizing your knowledge of those remarkable fossils for unravelling the stratigraphical problems presented by the contorted beds of the Scottish Borderland, and in applying the valuable experience thus acquired to the far more difficult examples of involved stratigraphy found in the county of Sutherland, you have exhibited a happy blending of those powers of patient observation and of bold generalization which are equally necessary for the man of science. Those who know you best will feel the least doubt concerning those "favours to come" in the shape of further work, the "lively sense" of which constitutes the staple of our gratitude to you to-day.

Prof. LAPWORTH, in reply, said :—Mr. President,—I am deeply sensible of the distinction which the Council of the Geological Society has conferred upon me in awarding me the Bigsby Medal ; and I am grateful, indeed, for the generous words in which you have referred to my geological work. If anything could add to the gratification with which I accept this award, it is that I receive it from the hands of one who, since the reading of my first paper before this Society, has been a staunch friend and a sympathetic adviser. I am afraid that the Members of this Society are a little inclined to rate my geological labours somewhat higher than they deserve, and I regard this Medal less as a reward for what I have done in the past than as a stimulus and encouragement for the future. The pursuit of original research has always appeared to me to be the highest and most pleasurable of enjoyments—and none the less pleasurable, as it has for years been associated in my mind with the unfailing interest, sympathy, and friendship accorded me by the Members of this Society. My leisure and means for work of this kind are, however, but small ; but I am sure that there is no need for me to assure the Society that such leisure and powers as I possess in the future will be wholly given to the service of that science to which we are all devoted.

The President then read his Anniversary Address, in which he gave obituary notices of the following Fellows of the Society who have died since the last anniversary :—The Earl of Enniskillen, Sir Charles Bunbury, Mr. George Busk, Mr. John Arthur Phillips, Mr. Henry Michael Jenkins, Dr. Harvey B. Holl, Mr. Caleb Evans, the Rev. Willlam Downes, Dr. Frederick Guthrie, and Mr. Arthur Grote. Also of the late Foreign Member, Dr. Hermann Abich, and of the deceased Foreign Correspondents, Professor Guiscardi and M. Cornet. In the Address proper, the President, after congratulating the Society on its present condition and prospects, and referring to some of the more notable incidents in the history of Geological Science during the past year, proceeded to discuss the past and pre-

sent relations between Mineralogy and the Biological Sciences. After insisting that the supposed distinction between living and non-living matter was not a fundamental one, he maintained that minerals resemble animals in possessing definite organization, and in going through regular cycles of change. He further pointed out that, in the course of its development, Mineralogy was now exactly following in the same lines which had been already taken by Zoology and Botany. He expressed his conviction that Geology and Mineralogy were powerful for mutual help, and that the latter science, now passing from the classificatory stage, had a great future before it.

The Ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—*President*:—Prof. J. W. Judd, F.R.S. *Vice-Presidents*: H. Bauerman, Esq.; Prof. T. G. Bonney, D.Sc., F.R.S.; A. Geikie, LL.D., F.R.S.; Henry Woodward, LL.D., F.R.S. *Secretaries*: W. T. Blanford, LL.D., F.R.S., and W. H. Hudleston, Esq., M.A., F.R.S. *Foreign Secretary*: Warington W. Smyth, Esq., M.A., F.R.S. *Treasurer*: Prof. T. Wiltshire, M.A., F.L.S. *Council*: H. Bauerman, Esq.; W. T. Blanford, LL.D., F.R.S.; Prof. T. G. Bonney, D.Sc., LL.D., F.R.S.; A. Champernowne, Esq., M.A.; Thomas Davies, Esq.; Prof. P. M. Duncan, M.B., F.R.S.; A. Geikie, LL.D., F.R.S.; Henry Hicks, M.D., F.R.S; Rev. Edwin Hill, M.A.; W. H. Hudleston, Esq., M.A., F.R.S.; J. W. Hulke, Esq., F.R.S.; Prof. T. M'Kenny Hughes, M.A.; Prof. T. Rupert Jones, F.R.S.; Prof. J. W. Judd, F.R.S.; R. Lydekker, Esq., B.A.; J. E. Marr, Esq., M.A.; E. T. Newton, Esq.; Prof. H. G. Seeley, F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S.; J. J. H. Teall, Esq., M.A.; Prof. T. Wiltshire, M.A., F.L.S.; Rev. H. H. Winwood, M.A.; Henry Woodward, LL.D., F.R.S.

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2.—February 23, 1887.—Prof. J. W. Judd, F.R.S., President, in the Chair. The following communications were read:—

1. "On the Origin of Dry Chalk Valleys and of Coombe Rock." By Clement Reid, Esq., F.G.S.

Whilst engaged in examining the Pleistocene deposits of Sussex, for the Geological Survey, the author observed that the Coombe Rock differs from anything commonly seen in the strongly glaciated districts of the Yorkshire and Lincolnshire Wolds. As in these localities, the seaward slope of the South Downs is broken by the line of a partially buried sea-cliff before passing under the low-lying drift areas. Subsequent to the formation of this sea-cliff a mass of angular flint and chalk detritus spread out from the Downs over the low lands, being seldom found far up the valleys. This is the Coombe Rock, which passes further on into a worthless mixture of angular flint and loam, and at a still greater distance into almost clean brick-earth. It is not of glacial origin, neither is it marine, nor is it a gravel formed by ordinary fluviatile action. A study of the contours of the Downs may give us, the author thinks, a key to the mode of formation.

The rolling outline of the Downs and the steep-sided dry valleys point to conditions which have passed away. However much rain may fall, the upper parts of these valleys are always dry, and no running water can be found where the incline of the bottom of the valley exceeds the slope of the plane of saturation—never more than 60 feet per mile. Three explanations have been offered:—

1. Former submergence and rise in level of the plane of saturation.

2. Former higher level of the plane of saturation before the valleys were cut down to their present depth.

3. Increase in the rainfall.

None of these theories is sufficient to account for the origin of Coombes and the transport of Coombe Rock. There is no evidence of submergence whilst the Coombes were being eroded; on the contrary, the descent of the Coombes to the sea-level near Rottingdean and elsewhere, is suggestive of a slight elevation. The deep trenching of the Downs by valleys, and the consequent lowering of the plane of saturation, is applicable to many of the slightly inclined Coombes, but the whole structure of the country shows that the outlet for the water must have been as clear then as now. Since the dry chalk valleys play no part in the present superficial drainage, it would make but little difference in the plane of saturation if they were filled up again. If springs had formerly existed in the higher valleys, their gradual failure would have left evidence in the shape of gravel deposits and terraces. Moreover, as an objection, both to the first and second theories, it is urged that if valleys had been cut back by springs, some of them should fall to the north, where most of the springs occur, whereas the Coombes open to the south. Lastly he finds no traces of the "hypothetical Pluvial period."

In suggesting an origin for the dry valleys and Coombe Rock, he considers that the fauna and flora, both at Fisherton and Bovey Tracey, point to a great degree of cold, from 20° to 30° lower than what now prevails in the South of England. The ground would thus be frozen to the depth of several hundred feet, and the drainage system of the chalk entirely modified. There would be no underground circulation. The summer rains would immediately run off any steep slope, often in violent torrents. These would tear up the layer of rubble already loosened by the frost, carrying down masses of unthawed chalk too rapidly for solvents to have much effect. No Coombe Rock is found in valleys that have a greater slope than 100 feet per mile. There is no need of excessive rainfall; it might have been a dry period corresponding to that of the Löss.

If the time had not been short, all soft rocks in the South of England would have been planed down to one gently undulating surface like the plains of Russia and Siberia. Such Tundra-conditions may have occurred more than once.

2. "Probable Amount of former Glaciation of Norway, as demonstrated by the Present Condition of Rocks upon and near the Western Coast." By W. F. Stanley, Esq., F.G.S.

The observations on which this paper are based were made in June last, during a voyage along the west coast of Norway. Inland conditions were also noted in the Hardanger and Sogne Fjords, and a few trips up some of the valleys enabled these inland observations to be further extended. The author limited his work in searching for outline evidence of ice-action. The aspect of the coast for hundreds of miles consecutively has a uniform character of jagged and pointed rocks nearly to the sea-level. At the mouths of the fjords the rocks are more rounded, particularly at heights less than 100 ft.

Within the Arctic Circle the Swartisen glacier reaches nearly to the sea, and here the rocks are more rounded.

He exhibited sketches showing the characteristic forms of the rocks, and concluded from a study of these that ice had never prevailed along the entire western coast of Norway, neither had inland ice of any considerable thickness flowed over this coast in sufficient volume to wear off the points of the sharply-fractured granite. Even the rocks below 100 feet are not more worn than is sometimes the case in tropical climates. The "shark's teeth" of the Lofotens have not been planed down, nor is there any vestige of the great ice-sheet of our text-books within the Arctic Circle. Even in the fjords there is no evidence of ice-action until we arrive at the head, where it is very evident. There can be no better demonstration of the extent of former glaciation than in the Romsdal valley, where the line of the worn base extends as high up the rock as 600 feet. He also instanced the principal glaciers of the Folge Fjord, now about 7 miles from the open water of the fjord, though formerly within $1\frac{1}{2}$ mile. The angular character of the low rocky island in front of Odde shows that it cannot have advanced further.

The author concluded that at no period within geologically recent, say Tertiary times, has ice extended much further than at present. Seeing that the morainic matter now in the valleys has been derived from the hills, there must formerly have been a greater extent of land above the snow-line, and this would cause a former extension of glaciers without resort to any extraneous theory or change of climate. The Great Ice Age has left no trace on the Norwegian littoral.

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## II.—Imperial Geological Institute, Vienna.

September 30, 1886. — "On new Neogene Isopoda," by N. Andrussow.

*Cymodocea Sarmatica*, Andr., from the dark-tinted Lower Sarmatian Clays of Kertch (Crimea), where it is associated with *Mactra Podolica*, Eichw., *Cardium obsoletum*, Eichw., *C. papyraceum*, Sinzoa, *C. Fittoni*, D'Orb., *C. Barboli*, R. Hörn., and several new species, *Modiola navicula*, Dub., *Tapes Vitaliana*, D'Orb., *Buccinum Verneuilii*, D'Orb., *B. substriatulum*, Sinz., *Trochus*, several species, *Polyzoa*, *Foraminifera*, *Vertebræ* of *Fishes*, and impressions of leaves, is remarkable, as being the first known undoubted fossil representative of the marine *Sphæromida*. All hitherto known fossil *Sphæromidæ* are *freshwater* forms, or belong actually to other families or even orders, such as the Inferior-Oolite species *Sphæroma Catullii*, Zigno. As early as 1868, Prof. Eichwald described *Sphæroma exsors*, from the Sarmatian Beds of Kijchenew (Bessarabia). *Palæga Anconitana*, Andr., from the "Schlier" of Ancon, is a counterpart of *P. Gastaldii*, Sism., from the Miocenes of Turin. Besides the above-mentioned two species, the other known *Palægæ* are *P. scrobiculata* from Karing (Tyrol), the Eocene *P. Catullii*, Zigno, sp., two Cretaceous species, and possibly the Cretaceous *Cymatoga Jazikowi*, Eichw., from Simbirsk on the Volga. *Ægites Kunthi*, Amm., is an Upper Jurassic representative of the family *Ægida*.

## III.—Zoological Society of London.

December 7th, 1886.—Prof. W. H. Flower, LL.D., F.R.S., President, in the chair.—The following communication was read :—

"On the Anatomy and Systematic Position of the Liassic Selachian, *Squaloraja polyspondyla*, Agass." By A. Smith Woodward, F.G.S.

After a brief notice of previous researches, the author attempted an almost complete description of the skeletal parts of *Squaloraja*, as revealed by a fine series of fossils in the British Museum. He confirmed Davies' determination of the absence of the cephalic spine in certain individuals (presumably females), and added further evidence of its prehensile character, suggesting, also, that the various detached examples afforded indications of one or more new species. The cartilages of the skull were, as far as possible, described in detail, and special attention directed to the palatine region, which appeared remarkably similar to that of the Myxinoids : there is a long forwardly-directed process on either side, evidently representing a pre-palatine element, and if the conclusions suggested by the present genus can be substantiated by an examination of other forms, the Selachian antorbital cartilage must fall under the denomination of post-palatine. A well-marked hyomandibular was noted, resembling that of typical Rays ; and each ramus of the jaw was shown to be provided with a single dental plate, exhibiting the ordinary Selachian mode of growth, and having the grinding surface rendered more efficient by a series of longitudinal rugæ ; to the latter there probably correspond some slight sutures, which allow of the shedding of the outer edge at intervals during growth. The pectoral fin shows but two basal cartilages, the preaxial being only about one-fourth the size of the postaxial ; and the pectoral girdle is of the Ray-type. The pelvic girdle is remarkable for the enormous size of the prepubic process, and there appear to have been no sutures in the basal cartilage of the pelvic fin, which passes, in the male, directly into the large clasper of either side. The author concluded with some general remarks on the affinities of the genus, and proposed to institute the new family of Squaloraiidæ, which may be placed near the Pristiophoridæ and Rhinobatidæ, and is conveniently defined as follows :—Body scarcely depressed, elongate. Head produced into a long flat rostrum, without lateral teeth. Males with a prehensile spine on the upper part of the snout. Dentition sharply divided at the symphysis. Pectoral fins with small propterygium, free.

## CORRESPONDENCE

### GLACIATED AND FACETTED BOULDERS IN THE PUNJAB.

Sir,—The statement of the case of the glaciated (?) rock-fragments of the Punjab has been thus far all from one side. As the "arch-heretic" who ventured to suggest that the four "Indian geologists," who took part in the discussion of the subject at Birmingham, had overlooked some important physical agencies, when they asserted

that no agency other than moving-ice could produce the effects observed, perhaps I may venture to ask for space for a few lines. I wish to point out that there appears to be considerable confusion of thought on this matter.

The rock-fragments are described now as "pebbles," now as "boulders," which are surely representatives of very different sets of mechanical forces. The term "pebble" is certainly a misnomer if applied to the two specimens which were exhibited at Birmingham. I saw and handled them both. The felsitic block had portions of its original surface somewhat smoothed, the sharper lines of its fracture somewhat rounded off in a fashion suggestive of the way in which the more flinty sarsens of this district acquire a certain degree of polish. The striated "facets" on this block are certainly difficult of explanation by reference to glacial agencies: they seemed to me very different from the ice-striations of blocks, of which I have had rather extensive observation in Alpine regions; nor can the necessary retention of the block in a fixed position in resistance to great and long-continued pressure be reconciled with the known physical properties of ice (see Q. J. G. S. February, 1883, pp. 62 *et seq.*).

The other block exhibited was more of a basaltic character, and was no doubt a slightly water-worn fragment of a basaltic column, as Prof. Carvill Lewis pointed out in the discussion at Birmingham. I do not recollect that this block was striated.

The question as to how the blocks came into their present position is entirely distinct from that of the agencies by which their present surface-character was given to them; and we have *no right to assume that these agencies acted upon them simultaneously*. On the contrary, Mr. Oldham's description[1] of the beds in which they occur affords, I think, convincing evidence to show that these facets and striations were produced by some agency or other *prior* to their deposition in the beds in which they now occur. This disposes at once of that writer's objection to the landslip theory (miscalled "soil-cap movement"), which I urged as the most likely explanation of the phenomena. In the discussion I referred to the objections of so excellent a physical geologist as Prof. Heim[2] of Zürich, to which I have on a previous occasion drawn attention in the pages of this Magazine (Decade II. Vol. X. pp. 160 *et seq.*), where it was also pointed out that the polishing and striations of the surfaces of fragments of rock by the slow grinding movement, which often goes on for years, was worthy of some consideration from their resemblance to some of the effects of glacial action. As I fail to see that this explanation has been met as yet by any insuperable objection, it will not be from mere obstinacy if I still adhere to it as upon the whole the most probable.

Mr. Oldham remarks on the origin of the name "Olive Group," and then a few lines further on says there is not "any sign of carbonaceous matter in the bed." Has chemical analysis decided this?

A. Irving.

Wellington College, Berks,
*January 8th*, 1887.

[1] *Vide* Geol. Mag. January, 1887, p. 32.

[2] "Ueber Bergstürze."

## THE BAGSHOT SANDS.

Sir,—Mr. Irving commences an article in the Geological Magazine for March (p. 111) with the following statement: "The chief object of this paper is to describe an unmapped outlier of Bagshot Sand." I have no desire here to raise the question of the age of the beds he has described in that article, especially as that subject was fully discussed on a paper read by Mr. Irving before the Geological Society in January last. But I wish to point out that, unless I have greatly misunderstood Mr. Irving's account of the geographical position of the outlier which he describes, the Bagshot Sand in question is neither *unmapped* nor does it form an *outlier*. In the Survey Map the Lower Bagshot Beds are represented as extending from the main mass westwards, between Barkham and Bearwood Park, including part of the latter, and sending off spurs to the southward, one of which "is crossed by the main road from Arborfield Cross to Wokingham," exactly as described by Mr. Irving. The only difference appears to be that Mr. Irving gives the beds a rather greater northerly extension than the Map. Moreover, the beds are not only mapped, they are also described. In the "Memoirs of the Geological Survey," vol. iv. page 314, we find the following:—"About three-quarters of a mile N.N.W. of Barkham, near Wokingham, there is light-brown fine micaceous glauconiferous sand, with thin layers of pipe-clay towards the top, about 12 feet thick, over a pebble-bed in whitish micaceous sand." This may possibly have been a description of the "Barkham Pit" described by Mr. Irving on p. 112. It agrees well enough in position, and the pit is said (p. 113) to have been "re-opened only last winter, after having been disused for years." It is true we find no mention of these beds in the list of outliers given in the memoir (*loc. cit.* p. 316); but, as I have stated above, the Survey considers that the sands are connected with the main mass.

It would seem, therefore, that in the alleged new outlier of Bagshot Sands, with which he has lately been puzzling those who are interested in Bagshot geology, Mr. Irving has only discovered an old friend.

R. S. Herries.

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## PALÆONTOGRAPHICAL SOCIETY.

Sir,—The volume for the year 1886, price one guinea, containing: (1) Stigmaria ficoides, by Prof. W. C. Williamson, with 15 plates; (2) Fossil Sponges, Part I. by Dr. G. J. Hinde, with 8 plates; (3) Jurassic Gasteropoda, Part I. No. 1, by Mr. W. H. Hudleston; (4) Inferior Oolite Ammonites, Part I. by Mr. G. S. Buckman, with 6 plates; (5) Pleistocene Mammalia, Part VI. by Prof. W. Boyd Dawkins, with 7 plates, is now with the binder, and will be issued to the Members toward the close of the present month,

The volume for 1887, of which nearly all the plates are ready, will be placed in the printer's hands at once, and will be distributed before the end of the year.

The new Monographs, on the Fossil Sponges, the Stromatoporoids, the Jurassic Gasteropoda, and the Inferior Oolite Ammonites, will require many plates for their illustration, and will be very costly. It would be a considerable aid to the Society if Members would mention these Monographs to those of their friends who are interested in such subjects, and if they would try to bring in new Subscribers.

25, Granville Park, Lewisham,
London, *7th March*, 1887.

Thos. Wiltshire,
Secretary.